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THE MISSISSIPPI MARKET FOR FLUID MILK

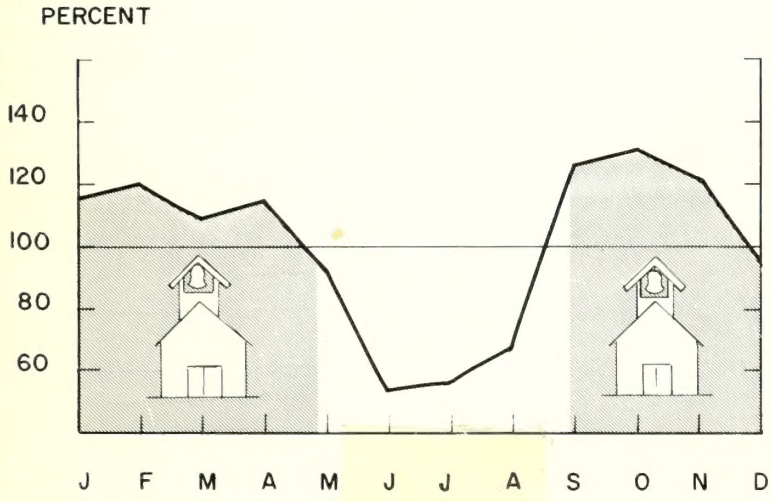

Chart 4. Seasonal variation in sales of flavored milk.

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ACKNOWLEDGMENTS

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This publication summarizes earlier, detailed reports by Charles Mack Young and David L. Trammell, both now members of the Mississippi Cooperative Extension Service staff, of research conducted under the leadership of Dr. Verner G. Hurt, of the University's Department of Agricultural Economics. The summary report was prepared by L. Dow Welch, also of the Department of Agricultural Economics.

HIGHLIGHTS

This brief report describes changes occurring over recent years in the size and ucture of the market for fluid milk in Mississippi and in the product composition of es, and examines packaging trends in the various fluid milk products. It also takes a k at the seasonality of sales, and at the responsiveness of sales of the various oducts to changes in prices and incomes.

While both per capita and total consumption of fluid milk in the State have in-ased substantially, the number of fluid milk processing firms has decreased. Miss-ppi processors have lost, and distributors for out-of-state processors have gained, a ater share of the Mississippi market.

There has been a general trend to the lighter-butterfat products. Whole milk prod-ts accounted for 81 percent of the sales volume in 1962, but only 76 percent of the 68 volume. In contrast, the skim milks and flavored milk gained from a 10-percent a 14-percent share of sales. Cream sales have declined, not only in relative, but also absolute, volume.

In most products there has been a trend away from the quart pack and from sales in lk containers. The plastic gallon jug had, in 1968, captured 5 percent of the all-oduct market. For other sizes of containers the 1968 volume shares were: Half-llons, 58 percent; half-pints, 17 percent; quarts, 13 percent: pints, 3 percent; and her packs, 4 percent.

Sales of most fluid milk products drop sharply in June-July and reach seasonal ghs in either the fall or late winter. Flavored milk is the most seasonal of all pro-ucts, with June sales about 45 percent below and October sales 30 percent above, the ormal monthly average. Generally, sales of half-pint and pint packs exhibit much arper seasonal variations than do sales of larger packs.

In contrast to the downward national trend, per capita sales of fluid milk products Mississippi have climbed steadily. Mississippi consumers bought enough fluid milk in 968 to afford every man, woman and child in the State 335 eight-ounce servings.

Sales of flavored milk (chocolate milk) are much more sensitive to price changes han are sales of other fluid milks. With market conditions as they were in 1962-68 a ne-percent change in price leads to more than a two-percent change in volume of avored milk sold, but only less than six-tenths of one percent in sales volume of ither whole milk, skim milk or buttermilk. Changes in consumer income have litde ffect on quantities of fluid milk purchased.

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THE MISSISSIPPI MARKET FOR FLUID MILK

By C. M. Young, D. L. Trammell, L. D. Welch
and V. G. Hurt

PART I

INTRODUCTION

The dairy industry is a vital part of ...issippi's economy. Milk production ...erates, on the average, around 7 per... of the State total of cash receipts ...n farm marketings. The processing ... distribution of milk and milk pro...ts employ vast numbers of workers, ... supply consumers with two impor... food items-fluid milk and manufac...ed milk products.

The fluid milk segment of the ...ustry has characteristics not common ... the manufactured milk segment. First, ...k for fluid uses must be produced ...der more stringent health requirements ...n is milk for other uses. Because of its ...h perishability, fluid milk requires a ...rketing system that will move the pro...ct quickly from producer to consumer. ...so, differences in consumer preferences ...cessitate that the product be offered in ...wide variety of forms, and in a variety ... container sizes, from half-pint to ...lon and even larger.

Currently on the market in Mississippi ... some 25 fluid milk products packaged ... seven different sizes of containers. ...us, in effect, nearly two hundred ...roducts" comprise the market offer...gs. The share of the market taken by ...ch of these products is by no means ...ble. And, because of the numerity of products, the short shelf-life, and the expense of packaging, changes in consumer preferences for the various products can have substantial impact upon suppliers. Yet, published data on trends in consumption of fluid milk afford scant, if any, information on the products individually. This situation heightens the need for a detailed analysis of consumption trends in specific products and sizes of package.

Objectives

The research reported herein is a part of a broad study of the marketing system for fluid milk initiated by the Department of Agricultural Economics, Mississippi Agricultural and Forestry Experiment Station, early in 1968. The current report is divided into two parts. Part I describes changes in the Mississippi market for fluid milk, including changes in the composition of fluid milk sales, and examines trends in product sales, by container size. It also takes a look at seasonality of sales, and at trends in per capita consumption of fluid milk products. In Part II the effects of changes in price and income on sales are examined.

The Data

Data on the sales of fluid milk products in Mississippi during the period 1962-1968 were obtained from milk processor and distributor reports filed with the now-defunct Mississippi Milk Commission. These monthly reports contained data on the total pounds, butterfat percentage, and the number of units sold for each of seven container sizes for 25 fl milk products. Sales volume data w converted to pounds and, for various p ducts and container sizes, percentages annual sales volumes were calculated. analysis the data were grouped into ei product classes (see Appendix Table

CHANGES IN MARKET SIZE AND MARKET SUPPLIERS

Sales of fluid milk products in Mississippi increased from 353 million pounds in 1962 to 424 million in 1968. The 20-percent expansion in sales arose from two market forces: increases in number of consumers and in per capita consumption, Table 1. The extent of growth in the latter force may be more readily comprehended if sales are expressed in half-pints, or normal servings per person per year--from less than 290 to 335 six years later.

Wide differences in the rates of change in quantities of the various products sold, Appendix Table 2, reflect the general consumer trend to lower-fat content products. Sales of homogenized milk, long the market leader, rose by less than 6 percent, while those of two-percent skim milk, a relatively new product, increased more than ten-fold. For such low-fat products as buttermilk and flavored milk, sales volumes expanded by one-fourth or more. In contrast, 1968 cream sales were off one-fifth or more from the six year earlier level.

Historically, the greater part of the market for fluid milk in the State has been supplied by Mississippi processors. In 1962 there were 37 such firms in the state although 7 of them--those with annual volumes in excess of 15 mill pounds--processed more than half of total volume of fluid milk processed w in the State, Table 2. But the decade the Sixties was one of adjustment in pl numbers and, by 1968, the number in State and fallen to 26. The sharpest d was in the number of firms with ann volumes of less than 5 million pounds fluid milk. Their number fell from 17 7, and their share of the State's p cessing volume from about 11 to less th 5 percent. Meanwhile, the number large-volume plants increased by one, a their share of output rose to abo two-thirds of the total.

Although their numbers were d lining, Mississippi processors, over t seven-year period, increased their outp of fluid milk products--some of whi was sold in other states--by about 14 p cent, Appendix Tables 3-5. But their o put did not keep pace with the sharp rising quantities demanded by the m ket, and they lost increasingly larg shares of the Mississippi market to di ributors for firms whose processing a packaging operations are based in oth states. These distributors doubled the sales volume and, by the end of 19 were supplying 12 percent of the volu

f uid milk sold in the state, Table 3.

For distributors, increases in market es for most products were substantial. y a few years earlier distributor sales reached 10 percent of the State total only a few low-volume specialty prod-s, classified as "other products" in Table 4. Now these sellers were supplying one-tenth or more of the market volume in almost every product, or product class. Their greatest boost in sales volume, however, came from their having taken a larger proportion of the market for homogenized milk.

TRENDS IN PRODUCT COMPOSITION OF THE MARKET

With expansions in a multiple-product arket comes expansion in the problems suppliers. Basic to solution of many of ose problems is the answer to this ques-n: What are the trends among the rious products the market comprises? r an awareness of those trends is ess-tial to the supplier who strives to keep s offerings adjusted to changes in con-mer preferences for the many products.

This report attacks that question by nalyzing changes over a seven-year eriod in the proportions of annual sales fluid milk—both in total and by type f supplier—accounted for by each of the ght classes of fluid milk products. The nalysis evinces changes in relative market opularity among the various products, ather than changes in absolute quantities old. To illustrate: Consumers in Miss-sippi bought about 15 million pounds nore of a certain product in 1968 than hey did in 1962. Yet, over the seven ears, the sales position of that product elative to all fluid milk products dropped rom 76 percent of the total to 67 per-ent because sales of the product did not xpand at as fast a rate as did sales of everal others.

Similar analyses—again by product class and by type of supplier—of trends in product packaging are also presented.

Product Distribution of Sales

Whole Milk: The most pronounced shift in product composition of the market has been a steady decline in the proportion of sales taken by whole milk products-homogenized, premium, and regular milk, and whole milk packaged for the military. These products still take the lion's share of the market, but the trend to products containing less fat cut their sales lead from about 81 percent of the total in 1962 to 76 percent in 1968, Table 5. In the years covered by the data, homogenized milk lost about one-twelfth of the market to other products, and thus offset substantial gains in market popularity by the other forms of whole milk.

Homogenized milk's drop in sales lead was much sharper for processors than for distributors. For processors, however, a major part of the shift was to other whole milk products, which in 1968 accounted for one-tenth of their sales volume. For consumers supplied by distributors, most of the change in preference apparently was from homogenized to skim milk and flavored milk.

Skim Milk: Skim milk is now available in two forms, regular skim and two-percent skim. Because the latter product has had

less of its animal fat removed than has regular skim, it retains more of the flavor of whole milk. That characteristic apparently has strong appeal to those consumers who like the taste, but not the fat content, of whole milk. In both the total market and that segment supplied by processors the share of sales taken by two-percent skim increased ten-fold in seven years, to reach about 4 percent of the 1968 total. For distributors, the product accounted for 2.3 percent of their 1968 sales volume.

Sales of regular skim milk declined, meanwhile to 1.6 percent of the 1968 total for processors, to 2.3 percent of the total for distributors, and to 1.8 percent of the overall market volume.

Buttermilk and Flavored Milk: In the entire market, and over the entire period, buttermilk maintained fairly stable proportions—around 8 percent--of the total sales volumes. For the two types of suppliers the slight trends were of about equal amplitude, but offsetting—upward by about one-half of one percent for processors, downward by about the same fraction for distributors, Table 5.

Flavored milk became an increasin important product, with its rela position in total fluid milk volume ris from 7.5 percent in 1962 to 8.8 perc in 1968. For both types of suppl trends were almost steadily upward: fr 7.6 to 8.8 percent of the processor to and from 5.9 to 8.6 percent of the d ributor total.

Cream, Heavy Cream, and Other Pr ucts: In none of the years covered by data did the combined volumes of pr ucts in these three classes reach 1.5 p cent of the volume of all fluid milk so For processors, light and heavy crea were two of the few products in wh sales volumes declined. For distribut cream sales volumes expanded slight but not in proportion to the growth all-product sales. The market share tak by minor specialty products (sour crea yogurt, tetra-pack, and the like), wh showing some increase, remained minu The trend was upward for processo downward for distributors.

TRENDS IN PACKAGING

Not only have there been changes in consumer preferences for the various fluid milk products in recent years, but also there have been significant shifts in the size of containers consumers find the most attractive. To examine trends in packaging, percentages of annual sales volume—first of all fluid milk products, and then of the various classes of products—marketed in each container size were calculated. Packaging includes gallons, half-gallons, quarts, third quarts, pints, half pints and bulk containers, i.e containers holding more than one gallo

All Product Sales: Over the years mo than half of the poundage of fluid mi products marketed in Mississippi has bee sold in half-gallon containers, with quar being the next most popular pack. An until 1968 the sales share taken by th half-gallon pack increased steadily, pr marily at the expense of sales in quart Table 6. But the plastic one-gallon ju

roduced to the Mississippi market in 65, slowly gained in popularity and in 68 seized a 5-percent share of the mar-, much of which earlier had been imed by half-gallons and quarts. In es by distributors this newly intro-ced pack was in even heavier demand, king nearly 8 percent of the entire 1968 tributor sales volume.

Bulk sales, primarily to institutional ers, became an increasingly less import-t part of total sales for both types of ppliers, dropping from about 6 percent less than 4 percent of the processor tal, and from about 2 percent to a gligible proportion of distributor sales. both the overall market and in that gment supplied by processors the pint d half-pint packs maintained fairly able proportions of sales-approximately 7 percent for half-pints and less than 4 ercent for pints. For distributors, how-ver, the half-pint pack gained substant-lly in market importance. In only one f the seven years did the third-quart ack account for more than 1 percent of he sales volume of either processors or listributors.

Whole Milk: Evidently the Mississippi housewife finds the convenience of the half-gallon carton much to her liking when buying whole milk. For several years that pack has claimed almost two-thirds of the total sales volume of whole milk, and its increasing popularity has caused a steady decline in the proportion of sales in quarts, Table 7. But by 1968 the gallon jug had begun to cut heavily into the sales lead held by half-gallon cartons. The market proportion held by the smaller packs has remained fairly stable-at about 14 to 15 percent for half-pints, around 2 percent for pints, and less than 1 percent for third-quarts. Bulk sales of whole milk have not expanded at the rate of other sales of the product and have thus become a smaller part of the product sales total.

Mississippi processors supplied 90 percent or more of the volume of whole milk sold in the State in four of the seven years covered by the data. Thus their trends in packaging essentially established the trends in the entire market for the product. For some container sizes, however—notably the gallon and half-pint—trends in sales by distributors differed strikingly from those in sales by processors.

Distributors first offered whole milk in gallon jugs two years after processors did, but for them this pack gained consumer preference more quickly than it had for processors. Within two years about 10 percent of their whole milk volume was distributed in plastic gallon jugs. And apparently the distributors found new outlets for their half-pints of whole milk, as, in the seven years, this pack gained steadily from a 10 to a 16 percent share of their whole milk sales. On the other hand, bulk sales, rarely as important a sales item for distributors as for processors, were, by the end of 1968, almost non-existant for distributors.

Two-percent Skim Milk: Until 1967 essentially all two-percent skim milk marketed in the State was sold in half-gallon containers, Table 8. Since then the quart pack has taken about 3 percent of processor sales volume and about 5 percent of distributor volume, to account for about 3 percent of total in-state sales of the product. Sales in containers other than half-gallon or quart cartons have been only minor.

Regular Skim Milk: For skim milk of less than 2 percent butterfat content the sales trend has been to half-gallons and away from quarts. Over the seven years the ratio of poundage sold in these two packs has changed from 35/63 to 58/39, Table 9. Also, the half-pint pack has shown considerable growth in sales importance—to 3 percent of the 1968 sales total. That trend could mean that many consumers are switching to low-fat milk when eating away from home.

Distributors have, over the years, sold a much higher percentage of their total volume of this product in half-gallons than have processors, and by 1968 that pack was accounting for 84 percent of their regular skim milk poundage and quarts less than 15 percent.

Buttermilk: Buttermilk is another product in which the half-gallon pack has, in recent years, markedly outstripped the quart in sales importance. In fact, since 1962 the relative sales positions of the two packs have been almost completely reversed, Table 10. Over the years these two packs have accounted for 98 percent of all buttermilk sales volume. Although pints have shown some growth in sales importance, they were, in 1968, still below 1 percent of total sales volume.

Between the two types of suppliers the ratios of sales in the various packs differed substantially. Distributors have consistently moved a larger proportion of their buttermilk volume in half-gallons than have processors, and for them the decline in importance of quarts has been less sharp. Also sales in pints and half-pints have taken somewhat larger proportions of the distributor total than of that of processors. In the past only processors have distributed buttermilk in containers larger than the half-gallon.

Flavored Milk: In this product the be seller has been the half-pint carton, wi pints in recent years edging out quarts f second place standing. In sales by pr cessors, however, half-pints have lo some of their lead to pints. As a resul over the seven-year span the percenta of total sales volume held by half-pin fell from 66 to 57 and that held by pin increased from 11 to 16, Table 11. Th heavy concentration of sales of flavore milk in half-pints, and a steady increase the importance of third-quarts-the tw individual-serving packs-evidence the fa that the principal markets for this pr duct are institutional ones. The sustaine growth of sales in half-gallons, howeve evidences a trend to heavier use of th milk in the home.

Most of the growth in sales of hal gallons, and all of that in pints, has bee in that part of the market supplied b Mississippi processors. Distributors hav experienced their heaviest gain in sales c half-pints.

Light Creams: The light-creams—a pr duct class which includes both ligh cream and half-and-half but exclude cream in the tetra-pack—are, in the mai sold in pints and quarts. The trend heavily to the smaller container. In 196 for either type of supplier, the volum ratio was roughly one-third in quarts an two-thirds in pints, Table 12. By 196 the ratio for processor volume had move to less than one-fourth in quarts an more than three-fourths in pints. In sale by distributors the trend away fro quarts has been even sharper. Sales o half-pints had, until 1968, been o relatively minorimportance. But in tha year such sales accounted for 17 percen of the distributor volume.

Heavy Cream: Until 1968 80 percent or more of the volume of heavy cream, whether sold by processors or by distributors, has been packaged in half-pints, Table 13. The only pronounced trend in the packaging of this product has been a sustained growth in distributor sales of quarts and a slight decline in the relative importance of quarts in processor market total.

SEASONALITY OF SALES

Though the long-time trend in sales has been strongly upward, market consumption of most fluid milk products is subject to seasonal ups and downs. Generally, market demand is somewhat weaker in the hot summer months than in other seasons, and over-all sales are lowest in. But within this broad sweep of seasonality lie many separate patterns for specific products, some much more high- pronounced than others. While these seasonal swings vary in amplitude from year to year they are approximately related with enough regularity to set "normal" seasonal patterns. Knowledge these patterns can be especially helpful planning sales of a product that is as perishable as is fluid milk, and one that can be differentiated in as many ways.

The charts below trace the patterns most likely to be followed by sales of the major fluid milk products in a "normal" year. The indexes in Table 14 describe the most common month-to-month variations in sales of the more important packages of these products. The indexes show, for each product and pack, the normal value for each month as a percentage of average monthly sales of that product in that pack. An index of, say, 90 for June means that in a normal year June sales volume of a specific product falls 10 percent below the average monthly level.

The indexes bring to light two general traits of seasonality in packaged milk that the charts obscure. In the main, the quart and larger packs—those bought by the housewife for family servings—exhibit considerably less seasonal fluctuation than do the smaller, single-serving packs. But sales of the smaller packs recover from their seasonal troughs in a shorter time. This latter characteristic is well exemplified by the pattern set by whole milk in half pints.

Whole Milk: After a late-Spring break, total sales of whole milk lag throughout the Summer and reach their seasonal high in September-November, Chart 1. It is the gallon and half-pint packs that contribute most to this pattern, for both half-gallons and quarts show remarkably slight month-to-month variations in sales, Table 14. Except that the decline begins earlier in the Spring, the seasonal pattern for gallons is strongly similar to that for total sales of whole milk.

The quick plunge to one-third or less of average monthly volume after May, when schools are out, and a secondary dip in December evidence the strong influence of the School Lunch Program on the movement of half-pint cartons of whole milk. (The effect is even more strongly pronounced for half-pints of flavored milk.) The pattern for pints— high volumes in the Summer and Fall, and below-average volumes in other months—

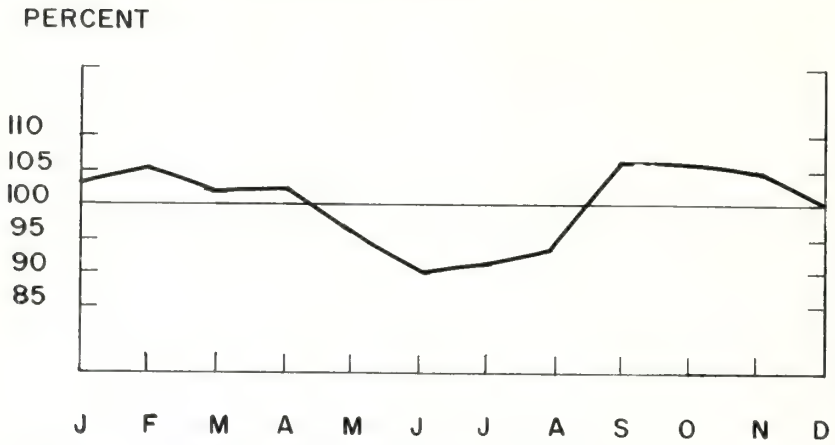

CHART 1. SEASONAL VARIATION IN SALES OF WHOLE MILK

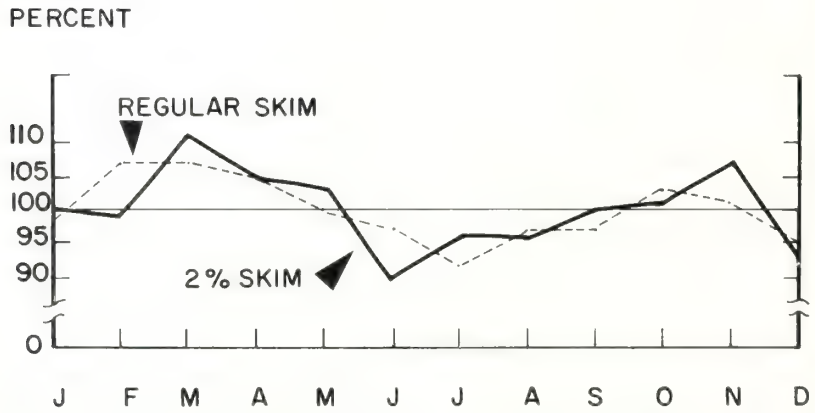

CHART 2. SEASONAL VARIATION IN SALES OF REGULAR AND 2-PERCENT SKIM MILK

closely corresponds to the seasonal pattern of employment in the State's manufacturing and construction industries, and identified the market for milk in pint cartons as workers who enjoy a cold draft of milk with their packed lunches.

Skim Milk: Sales of both two-percent and regular skim milk are heaviest in the Spring and lightest in June-August, Chart 2. Both products normally exhibit a sharp secondary drop in December. Highs and lows are slightly more pronounced two-percent than in regular skim.

Buttermilk: July is the low month f buttermilk, with sales volume droppin on the average, 6 to 7 percent, Chart 3. the cooler months fluctuations in sal are only minor. In this product the effe of warm weather on sales is slightly mo well-defined in half-gallons than in quart Half-gallons begin their seasonal slum earlier and maintain it longer than c quarts.

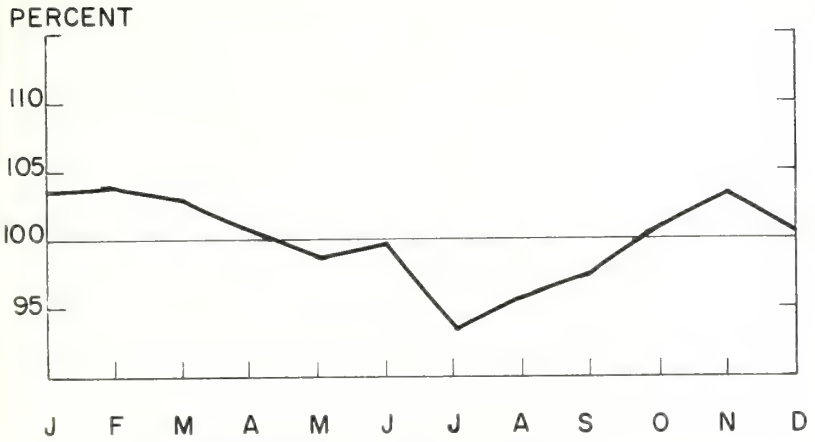

CHART 3. SEASONAL VARIATION IN SALES OF BUTTERMILK

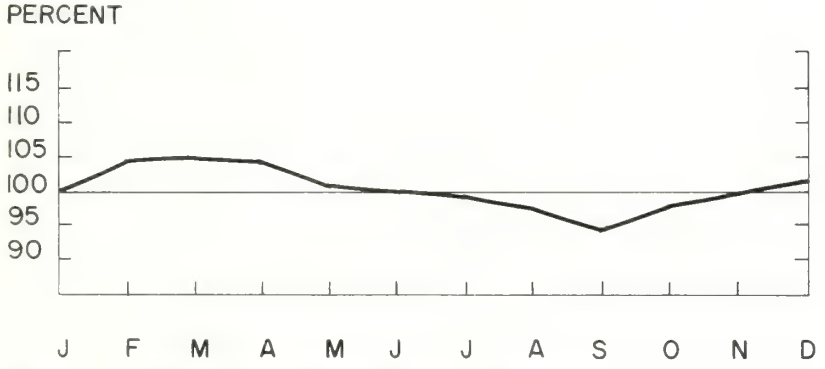

CHART 5. SEASONAL VARIATION IN SALES OF HALF-AND-HALF

lavored Milk: Extreme seasonality in alf-pints strongly influences the pattern f total sales of flavored milk, which ops drastically in June and does not re- over until school bells ring in September, hart 4. Month-to-month variations in oth pint and half-pint sales volumes of his product almost exactly duplicate hose for corresponding packs of whole milk, Table 14. This remarkable similarity in sales patterns strongly suggests that the major markets for both whole and flavored milk in these packs are the same—for half-pints, children in school; and for pints, production workers who eat either a packed lunch or a quick lunch at a snack bar.

Sustained heavier sales of quarts of fla-

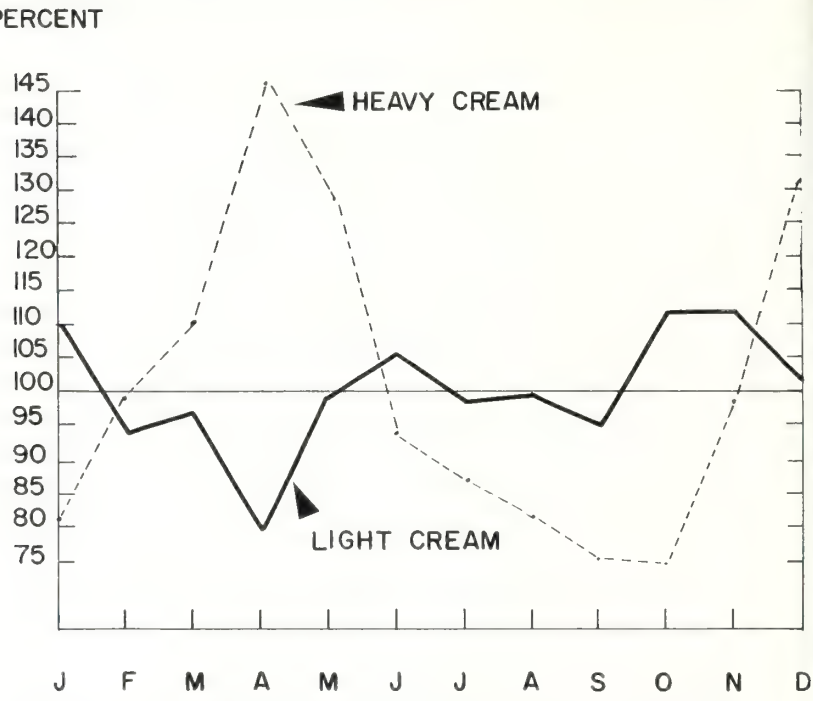

CHART 6. SEASONAL VARIATION IN SALES OF HEAVY AND LIGHT CREAM

vored milk with the onset of cool weather reflect the popularity of chocolate milk served as a hot beverage on a cold day.

Cream: Sales of heavy cream normally peak twice during the year—in April-May and in December, Chart 6. The latter rise is, of course, attributable to the custom of holiday feasts at Christmastime, and April-May is the period of heaviest m ment of strawberries at supermarkets

The markets for both light cream half-and-half are primarily instituti ones. While the seasonal trends in mo ly sales volumes of half-and-half, a co cream, are not so pronounced as are th for heavy cream, they apparently are by trends in coffee drinking.

TRENDS IN PER CAPITA SALES

The population of the State increased but little in the seven years for which sales data were analyzed. Thus the 20-percent increase in fluid milk sales came about primarily through heavier purchases per consumer. Had every Mississippi resident in 1968 shared equally in the market consumption of fluid r products that year, each would h bought about 332 eight-ounce glasse milk, and more than three half-p cartons of cream products. A 1968 su in sales of both whole and low-fat n brought per capita sales for that yea

out 24 average servings above the year-rlier level and to about 46 servings per rson above the average for 1962, Table 5.

Apparently the increased consumption low-fat milk has brought new users to ie market, for there has been no down-end in per capita sales of whole milk in lississippi, as there has been elsewhere the nation. To the contrary, increased ales of whole milk accounted for almost alf of the State's seven-year rise in sales er person. And, in 1968, when sales of ow-fat products were highest for the eriod, per capita sales of whole milk ook a substantial 12.6 half-pint jump.

A closer look at low-fat product sales eveals the impressive growth rate of con-umption of two-percent milk. Per capita ales of skim milk, while far behind those of either flavored milk or buttermilk, much more than doubled in seven years, and, in the latter part of the period, all of the increase can be credited to the mounting popularity of two-percent skim. Undoubtedly, the school lunch program in the State was highly instrumental in flavored milk's reaching its almost 30-servings per person consumption level in 1968.

Per capita sales of cream and cream products, meanwhile, inched downward. But the drop in these products in Mississippi was not nearly so sharp as that which was occurring nationally. Table 16 highlights this and other differences in the changing patterns of market milk consumption per person in the State and in the nation. One of the most outstanding of these differences is that while, nationally, per capita purchases of the low-fat milks have climbed much faster than in Mississippi, the increased use per person has not been large enough to offset declines in whole milk and the creams. Thus while the average Mississippian was buying one-sixth more fluid milk products than in 1962, the average American in other parts of the nation had decreased his purchases of these products by one percent.

PART II
THE DEMAND FOR FLUID MILK

Without doubt the Mississippi market for fluid milk will undergo changes beyond those discussed earlier in this report. Changes in both the size and the composition of the population are expected to add more consumers to the market. Suppliers will continue to vie, perhaps even more intensely than in the past, for larger shares of sales. In all likelihood there will be further innovations in packaging. It is also highly probable that new products, whether further differentiated fluid milk products or products of non-dairy origin, will be placed on the market. Upon changes such as these hinge further expansions in the volumes of the various fluid milk products moving through the market.

But other changes will directly affect per capita consumption of milk and thus heavily influence market growth. Personal income per capita is generally expected to show steady increases over time. But with improvements in income normally come increases in prices, and all product prices do not rise uniformly. Also, that con-

sumers are notably fickle in their tastes and preferences is well attested by the continued success of advertising agencies. Changes in either preferences, price relationships, or income can have substantial impact upon the demand for fluid milk products.

Changes in tastes and preferences are unpredictable, and so is their impact on market growth. The effect of changes in prices, or in incomes, upon the aggregate value of sales of a product can, however, be estimated if the nature of the demand curve of the product is known. (By "demand curve" is meant the quantities that will be taken at any of a series of likely prices.)

The Concept of Elasticity

Sales of all products do not show the same responsiveness to a given market stimulus. A given change in prices, or in money available to consumers, may cause a much larger change in the quantity of one product sold than in that of another. Alfred Marshall, a renowned British economist of an earlier day, introduced the concept of elasticity of demand to measure the relative degree of sales expansion and contraction in response to these stimulii. If, for instance, a 1 percent change in the price of a product brings forth a change of more than 1 percent in quantity taken, the demand for that product is said to be elastic as to price. If the change in quantity taken is less than proportional to the change in price, the demand is then said to be inelastic. If price and quantity changes are of identical proportions, the elasticity is described as unitary. Elasticity estimates, then, are expressed as relationships between percentage changes, and since price and quantity move in opposite directions, the sign is negative. Thus, a price elastici estimate of -1 indicates unitary price ela ticity; an estimate of, say, -2.312 i dicates a relatively elastic demand for t product; and an estimate such as -0.1 indicates a highly inelastic demand.

The significance of such estimates t the seller lies in the relationship of pric change and expected changes in total re enue from sales of the product. Wit other conditions remaining constant, a increase in product price will increas total sales revenue only if the demand fo the product is inelastic. If the demand i elastic, a price increase will cause sales t decrease more than proportionally an total revenue to fall. Of course, a pric drop will have the opposite effects o total revenue. If the price elasticity of th product is unitary, a price change i either direction will have no effect o sales receipts.

In a similar manner **income elasticity** measures the response of market con sumption to changes in consumer in comes. Income elasticities, like price elasticities, vary considerably among products. A difference is that income elasticities can be either positive or negative. Basic food groups and other necessities usually have low positive income elasticities, i.e., an increase in consumer incomes will bring about a less than proportional increase in consumption of these goods. If consumption declines with an increase in income, as sometimes occurs with an inexpensive good for which there is a more desirable, but more costly, close substitute, the income elasticity of the product is said to be negative.

Fluid milk is, of course, a basic food, and one considered by many to have no close substitute. Thus the demand for it,

erally, has been deemed highly inelastic. But, as we have seen earlier, fluid milk is sold in numerous forms, some of which substitute well for each other. Reliable estimates of the likely responses of sales of these various "products", then, to price and income changes could be of considerable value to the industry in formulating pricing policies. An understanding of these inter-product demand relationships should also aid in anticipating the impact of new substitutes that may be placed on the market. Such understanding, combined with better knowledge of the effect of seasonality on sales, should also afford a sounder basis for beforehand evaluation of the effectiveness of any proposed activity to promote fluid milk consumption. It is the scope of Part II of this report to present estimates, developed from 1962-1968 data, of the effects of changes in price and income upon sales of the various fluid milk products in the Mississippi market.

The Data

Estimates of demand elasticity are derived through solution of mathematical "models",or equations. The estimates presented later in this report were developed through two such models.* On the premise that detailed discussion of statistical methodology would prove boring to most readers we say here only that the components of the equations were sales quantities; prices; income; and time, that is, the 84 months elapsing in the period covered by the data. In each instance quantity was the dependent variable—changes in sales depend upon changes in the other three components of the equations.

Sales data were the same as those on which Part I of the report was based—quantities from suppliers' monthly reports to the Mississippi Milk Commission—except that for the demand analyses sales units were not converted to pounds. Prices were minimum retail prices established by the Commission for the Delta-Central Marketing Area, and income data were estimates of monthly levels of per capita personal income in Mississippi.

Over a seven-year span both the size of the population and the purchasing power of money are subject to changes that can cause shifts in demand. To adjust for population changes sales data for each of the 84 months were converted to average daily sales per thousand persons. To adjust for changes in the value of money—changes in the general price level—both prices and per capita incomes were deflated to 1957-59 levels. Inclusion of time as a variable in the equations makes allowances for seasonal differences in sales. (All basic data used in the analyses appear in the Appendix to this report.)

The Estimates

In estimating the responsiveness of sales to changes in market conditions the product classification used in Part I of this report was followed—whole milk; the two classes of skim milk; buttermilk; flavored milk; the light creams; the heavy creams; and miscellaneous specialty products. For products offered in containers of various sizes the estimates derived through each of the two models included an overall appraisal in terms of the best-selling package.

By far the preponderance of the 112

estimates shown in the tables below were logical as to sign. That is, they indicated that the change in sales following a change in either price or income would be in the direction normally expected. In some instances, however, estimates yielded by the two models for a product in a specific size of container were rather widely divergent. Generally, the two estimates for overall sales of a product, or a class of products, without regard to size of container more nearly coincided than did those for specific sales items. And only rarely did these estimates for composite sales bear illogical signs.

Whole Milk: Evidently, overall sales of whole milk are somewhat less responsive to changes in price than are those of either skim milk, buttermilk, or flavored milk. With market conditions as they were in 1962-1968 a 1 percent change in price can be expected to be followed by only about a four-tenths of one percent change in sales of whole milk products, Table 1. Furthermore, sales response to a similar change in consumer incomes is even less—not quite three-tenths of one percent. Changes in either price or income, however, have a considerably heavier impact upon sales of the product in half-gallon cartons—the most popular pack—than upon whole milk sales in general. Even so, the estimates reveal that the demand for the product, even in its best-selling pack, is well within the range of inelasticity.

For whole milk in other than half-gallon cartons the estimates were rather erratic. These differences may have arisen because of situations not fully considered in the estimating procedure—the rapidly changing popularity of certain packs and different methods of pricing for sales through school lunch programs through vending machines are example Despite this apparent shortcoming th close agreement of the estimates yield by the two models in the instances both composite sales and sales in ha gallon cartons lends strong credence the appropriateness of the procedure.

Skim Milk: Estimates of elasticity f each pack in which skim milk is offere were not calculated, since, for som items, sales were only minor. But the da indicate that aggregate sales of regul skim milk drop by about six-tenths one percent when prices are increased b 1 percent, Table 18. Overall sales of th product show little response to changes i consumer incomes. Sales of half-gallon the leading pack, are slightly mo sensitive to price change than are eith quart or aggregate sales. They are als fairly sensitive to income changes.

Sales volume of the newer skim mil product, two-percent skim, as was show in Part I of this report, increased ten-fol in the seven-year span of the data. Cor sumer incomes, meanwhile, far less tha doubled. The wide disparity in thes growth rates in all probability resulted i an overestimation of the sales response o the product to income changes. The rapi growth in market popularity likel accounts, too, for the wide divergence i the estimates of the price effect on two percent skim milk sales.

Buttermilk: The price elasticity of th half-gallon pack of buttermilk is evidentl more nearly unitary than is that of an other product for which estimates wer derived. The implication is that change i the price of this item—at least such changes as occurred in 1962-1968—have

almost imperceptible effect upon sales revenue. Indications are that sales revenue from the quart pack, on the other hand, is highly affected by price changes. The estimates in Table 19 also suggest that sales of buttermilk show more response to changes in consumer income than to price movements.

Flavored Milk: Apparently, aggregate sales of flavored milk react sharply to price change. Estimates reveal, however, that the price elasticity of the half-pint pack is substantially less than is that for quarts, Table 20. They also indicate that while the demand for the product in pints is only slightly affected by price change it is much more highly responsive to changes in consumer income than is that for any other pack.

Other products: The creams and specialty products have in recent years accounted for only about 1 percent of total fluid milk sales volume. Elasticity estimates for these products, Tables 21-22, were somewhat erratic and signified, in some instances, a demand impact in a direction that would not logically be expected. It is logical to suspect, for example, that the demand for either half-and-half or heavy cream would be only slightly lessened by a price increase, as the estimates suggest. But it is hardly logical, however, to accept the implication that as incomes rise consumers use less of these products. Nor is it reasonable to believe that consumers will buy more light cream and yogurt at a higher price than at a lower one. There are, however, plausible explanations for the failure of the mathematical models to yield estimates for these products that are more consistent with economic theory. By no method yet devised can the singular influence of every factor known to affect demand be accurately measured. The impact of changes in tastes and preferences is not subject to definitive measurement. A number of products considered to be substitutes for the cream products were placed on the market during the period covered by this study. The increased emphasis placed on dieting in recent years doubtlessly contributed to the trend away from the high-fat products and toward lower-fat dairy or non-dairy products. Since both this trend and the trend to higher consumer incomes are highly correlated with time, the decreases in purchases indicated by the negative income elasticity estimates were likely reflections of changes in tastes and preferences, of substitution, and of other factors not considered rather than of the true income effects.

Evaluation of Results

Not in every instance are the two estimates for the various product-container size combination in close agreement. In the main, however, at least one of the two appears to be a reasonably acceptable estimate. Although all met the standard criteria for statistical reliability, they are what they purport to be, carefully derived estimates, not precise measurements. They should be interpreted in light of two limitations inherent in all demand evaluations: the inability to weigh separately all factors known to influence demand, and the range over which the pertinent variables move.

Thus, the comments made earlier about the unobserved effects of changes in tastes and preferences and product substitution apply to all estimates —though perhaps to a lesser degree for some products than in the instance of the creams.

Also, the price elasticity estimates must be interpreted as being applicable to a rather narrow range of price movements rather than to the road spectrum of all possible prices. During the period considered in the study, prices of homogenized milk in half-gallon cartons, for example, varied from 52 to 61 cents, and prices for some products varied even less.

To the knowledge of the authors, no other research has been conducted to estimate elasticities for specific fluid milk products by size of containers. Most earlier investigations have been concern with the demand for fluid milk produ in the aggregate. Hurt and Gamble 1969 estimated price response for sev classes of fluid milk products without gard to container size. Overall, it appe that many of the estimates reported he in for aggregate sales of the various pr ducts compare favorably with their fin ings. While this favorable comparison, itself, does not validate the estimates, does lend additional evidence and suppo for them.

Table 1. FLUID MILK SALES: Total and per capita, Mississippi, 1962-1968.

Year	Total sales[1/]	Population[2/]	Per capita sales
	(Pounds)	(Number)	(Pounds)
1962	353,460,200	2,263,158	156.2
1963	366,298,100	2,288,185	160.1
1964	377,894,100	2,313,604	163.3
1965	394,986,100	2,330,743	169.5
1966	402,643,200	2,354,060	171.0
1967	398,743,800	2,358,878	169.0
1968	424,042,800	2,344,810	180.8

1/ From Appendix Table 2.

2/ United States Bureau of the Census, Current Population Report, Series p. 25, Nos. 343 (1967) and 373 (1968).

Table 3. Distribution of fluid milk sales, by type of seller, Mississippi, 1962-1968.

Year	Total Sales	Type of Seller			
		Processors		Distributors	
	Thous. lbs.	Thous. lbs.	Percent	Thous. lbs.	Percent
[illegible]	353,460	328,448	92.9	25,012	7.1
1963	366,298	329,260	89.9	37,038	10.1
[illegible]	[illegible]	345,781	[illegible]	32,114	8.5
[illegible]	394,986	359,533	91.0	35,453	[illegible]
1966	[illegible]	[illegible]	90.9	36,451	[illegible]
1967	[illegible]	357,766	89.7	[illegible]	10.3
1968	[illegible]	373,090	88.0	[illegible]	12.0

Table 4. Percentages of the market supplied by processors and by distributors by product class, Mississippi, 1962 and 1968.

Product Class	Type of Suppliers and Year			
	Processors		[illegible]	
	1962	1968	1962	1968
	Percent of Total Sales			
Whole Milk	92.8	87.8	7.2	[illegible]
Homogenized	92.5	86.[illegible]	[illegible]	13.[illegible]
Other	[illegible]	[illegible].0	1.[illegible]	[illegible]
Two-percent Skim	[illegible]	[illegible]	0.1	7.3
Regular Skim	92.8	80.[illegible]	[illegible].2	19.[illegible]
Buttermilk	[illegible].6	89.0	[illegible]	[illegible].0
Flavored Milk	[illegible]	88.[illegible]	[illegible]	11.8
[illegible]	[illegible].9	[illegible]	8.1	[illegible]
Heavy Cream	[illegible].9	87.[illegible]	[illegible].1	[illegible]
Other Products	31.[illegible]	87.[illegible]	[illegible]	12.[illegible]
All Products	[illegible]	88.0	[illegible].1	[illegible].0

ble 5. ALL FLUID MILK SALES: Distribution by product class, total, processor, and distributor sales, Mississippi, annual, 1962-1968.

Product class[1]	Year						
	1962	1963	1964	1965	1966	1967	1968
	Percent						
ALL SUPPLIERS							
ole milk	80.81	79.42	78.96	78.10	77.87	77.74	76.41
Homogenized milk	(76.37)	(72.35)	(72.89)	(67.76)	(64.88)	(64.49)	(67.35)
Other whole milk[2]	(4.44)	(7.07)	(6.07)	(10.35)	(12.99)	(13.25)	(9.06)
percent skim milk	.38	.72	1.07	1.52	2.20	2.95	3.80
gular skim milk	2.22	2.17	2.21	2.25	2.03	2.01	1.76
ttermilk	7.80	7.88	8.12	8.20	8.06	8.09	8.19
avored milk	7.48	8.57	8.45	8.79	8.73	8.14	8.81
eam[3]	.93	.87	.80	.73	.67	.60	.54
avy cream	.19	.17	.17	.16	.15	.14	.13
her products	.19	.20	.22	.25	.29	.33	.36
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
PROCESSORS							
ole milk	80.72	78.91	78.80	77.98	77.71	77.56	76.26
Homogenized milk	(76.02)	(71.30)	(72.26)	(66.64)	(63.48)	(62.90)	(66.18)
Other whole milk[2]	(4.70)	(7.61)	(6.54)	(11.34)	(14.23)	(14.66)	(10.08)
percent skim milk	.41	.80	1.14	1.60	2.33	3.18	4.01
gular skim milk	2.22	2.09	2.10	2.12	1.85	1.78	1.60
ttermilk	7.78	8.03	8.15	8.25	8.11	8.17	8.28
avored milk	7.60	8.94	8.66	8.94	8.92	8.25	8.82
eam[3]	.91	.88	.79	.72	.67	.59	.53
avy cream	.19	.17	.16	.16	.14	.14	.13
her products	.17	.16	.20	.23	.27	.33	.37
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
DISTRIBUTORS							
ole milk	81.98	83.86	80.67	79.39	79.40	79.24	77.53
Homogenized milk	(81.01)	(81.72)	(79.66)	(79.02)	(78.95)	(78.30)	(75.99)
Other whole milk[2]	(.97)	(2.14)	(1.01)	(.37)	(.45)	(.94)	(1.54)
percent skim milk	.00	.00	.33	.39	1.02	.95	2.31
egular skim milk	2.26	2.89	3.47	3.91	3.76	3.99	2.86
uttermilk	8.11	6.55	7.85	7.61	7.51	7.35	7.49
lavored milk	5.87	5.26	6.17	7.25	6.92	7.19	8.65
ream[3]	1.06	.83	.89	.82	.77	.68	.65
eavy cream	.25	.15	.20	.17	.18	.16	.14
ther products	.47	.46	.42	.46	.44	.44	.37
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

1/ For specific products in each class see Appendix Table 1.
2/ Includes regular, military, and premium milk.
3/ Light cream and half-and-half in containers other than tetra-pak. Sales in tetra-pak included in "Other Products".

Table 6. ALL FLUID MILK: Total, processor, and distributor sales volume distribution by size of container, Mississippi, Annual, 1962-1968.

Size of [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1967	[illegible]
			Percent				
ALL SUPPLIERS							
Bulk	5.67	5.[illegible]	4.91	4.69	5.3[illegible]	4.00	3.28
Gallon	0	0	0	.07	.16	1.50	4.98
Half-Gallon	50.80	54.00	55.99	57.51	58.2[illegible]	59.30	58.[illegible]0
Quart	24.32	21.10	18.78	17.04	15.33	13.97	12.52
Third-Quart	.20	.[illegible]3	.20	.[illegible]2	.22	.[illegible]6	.88
Pint	2.7[illegible]	3.10	3.40	3.[illegible]0	3.5[illegible]	3.35	3.42
Half-Pint	16.23	16.31	16.72	16.7[illegible]	17.16	17.4[illegible]	16.72
Total	100.00	100.[illegible]0	100.00	100.00	100.0[illegible]	1[illegible]0.00	100.00
PROCESSORS							
Bulk	5.94	5.60	5.18	4.5[illegible]	5.56	4.23	3.73
Gallon	0	0	0	.0[illegible]	.11	1.66	4.61
Half-Gallon	50.05	5[illegible].14	54.97	56.[illegible]0	57.61	58.[illegible]2	58.[illegible]1
Quart	24.56	21.[illegible]4	19.16	17.37	15.59	14.24	12.7[illegible]
Third-Quart	.19	.20	.15	.16	.[illegible]9	.42	.[illegible]6
Pint	2.73	3.[illegible]5	3.38	3.70	3.50	3.33	3.38
Half-Pint	16.53	17.07	17.16	17.[illegible]1	17.[illegible]4	17.50	16.45
Total	100.00	100.[illegible]0	100.00	100.00	100.00	100.00	100.00
DISTRIBUTORS							
Bulk	2.11	2.20	2.10	5.78	2.[illegible]6	1.98	.01
Gallon	0	0	0	0	0	.12	7.72
Half-Gallon	60.54	70.53	66.92	63.73	66.34	65.15	58.03
Quart	21.25	13.[illegible]0	14.[illegible]9	13.66	12.70	11.61	10.[illegible]1
Third-Quart	.37	.47	.63	.81	1.48	.[illegible]8	.[illegible]9
Pint	3.49	3.4[illegible]	3.63	3.49	3.45	3.48	3.[illegible]0
Half-Pint	12.[illegible]4	9.[illegible]2	12.03	12.[illegible]3	13.[illegible]7	16.78	18.75
Total	100.00	100.[illegible]0	100.00	100.0[illegible]	1[illegible]0.00	100.00	100.00

able 7. WHOLE MILK: Total, processor, and distributor sales volume distribution by size of container, Mississippi, annual, 1962-1968.

Size of container	1962	1963	1964	1965	1966	1967	1968
	Percent						
ALL SUPPLIERS							
Bulk	6.91	5.76	5.69	5.40	5.99	4.57	3.70
Gallon	0	0	0	.08	.12	1.93	6.51
Half-Gallon	58.06	62.07	63.61	64.83	65.17	65.07	63.18
Quart	19.65	16.60	14.40	13.01	11.61	10.40	9.14
Third-Quart	.16	.19	.17	.17	.16	.39	.72
Pint	1.59	1.79	1.99	2.23	2.11	1.98	1.98
Half-Pint	13.63	13.59	14.14	14.28	14.84	15.66	14.77
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
PROCESSORS							
Bulk	7.25	6.15	5.99	5.31	6.26	4.32	4.22
Gallon	0	0	0	.09	.14	2.14	6.03
Half-Gallon	57.31	60.20	62.60	64.25	64.35	64.34	63.20
Quart	19.86	17.45	14.79	13.33	11.87	10.65	9.32
Third-Quart	.13	.16	.12	.12	.07	.33	.70
Pint	1.57	1.78	2.00	2.28	2.14	1.99	1.97
Half-Pint	13.68	14.26	14.50	14.62	15.17	15.73	14.54
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
DISTRIBUTORS							
Bulk	2.49	2.55	2.57	6.27	3.34	2.43	.01
Gallon	0	0	0	0	0	.14	9.14
Half-Gallon	67.95	77.60	74.50	70.00	73.15	71.43	62.92
Quart	10.93	9.48	10.33	9.86	9.12	8.24	7.79
Third-Quart	.45	.48	.64	.65	1.13	.80	.88
Pint	1.83	1.85	1.83	1.72	1.73	1.88	2.08
Half-Pint	10.35	7.03	10.27	10.90	11.53	15.08	16.38
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 3. TWO-PERCENT SKIM MILK: Total, processor, and distributor sales volume distribution by size of container, Mississippi, annual, 1962-1968.

Size of Container	1962	1963	1964	1965	1966	1967	1968
				Percent			
				ALL SUPPLIERS			
Bulk	.01	.35	.48	.35	.23	.21	1/.37
Half-Gallon	99.99	99.65	99.51	99.18	98.99	97.82	95.67
Quart	0	0	.01	.45	.76	1.88	3.05
Half-Pint	0	0	0	.02	.02	.09	.91
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
				PROCESSORS			
Bulk	.01	.35	.49	.36	.24	.22	.38
Half-Gallon	99.99	99.65	99.51	99.16	99.03	97.85	95.81
Quart	0	0	0	.46	.71	1.86	2.88
Half-Pint	0	0	0	.02	.02	.07	.93
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
				DISTRIBUTORS			
Gallon	0	0	0	0	0	0	.22
Half-Gallon	100.00	0	99.46	99.67	98.12	96.99	93.78
Quart	0	0	.54	.33	1.88	2.55	5.28
Half-Pint	0	0	0	0	0	.46	.72
Total	100.00	0	100.00	100.00	100.00	100.00	100.00

1/ Includes small quantity in gallon containers.

Table 9. REGULAR SKIM MILK: Total, processor, and distributor sales volume distribution by size of container, Mississippi, annual, 1962-1968.

Size of Container	1962	1963	1964	1965	1966	1967	1968
				Percent			
				ALL SUPPLIERS			
Bulk	.35	.15	.23	.48	.36	.19	.08
Gallon	0	0	0	0	0	0	.03
Half-gallon	34.95	36.88	43.52	49.36	50.72	56.56	58.07
Quart	63.18	61.06	53.62	47.20	45.63	39.96	38.63
Half-pint	1.52	1.91	2.63	2.96	3.29	3.29	3.19
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
				PROCESSORS			
Bulk	.33	.18	.24	.47	.40	.17	.10
Half-gallon	33.97	31.92	39.49	44.20	44.83	49.75	51.76
Quart	64.10	65.79	57.49	52.16	51.23	46.31	44.48
Half-pint	1.60	2.11	2.78	3.17	3.54	3.77	3.66
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
				DISTRIBUTORS			
Bulk	59	0	.17	.53	.13	.27	0
Gallon	0	0	0	0	0	0	.17
Half-gallon	47.50	68.70	69.84	77.63	79.84	83.20	84.05
Quart	51.43	30.62	28.34	20.04	17.98	15.15	14.54
Half-pint	.48	.68	1.65	1.80	2.05	1.38	1.24
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 10. BUTTERMILK: Total, processor, and distributor sales distribution by size of container, Mississippi, annual, 1962-1968.

Size of Container	1962	1963	1964	1965	1966	1967	1968
	Percent						
ALL SUPPLIERS							
Bulk	.16	.14	.11	.09	.08	.06	.07
Gallon	0	0	0	.03	.03	.04	.01
Half-gallon	34.70	40.13	45.00	49.58	51.84	54.54	58.24
Quart	63.99	58.43	53.47	48.74	46.18	43.52	39.77
Third-Quart	.07	0	0	0	.04	.13	.39
Pint	.47	.67	.76	.82	.88	.91	.95
Half-pint	.59	.63	.66	.74	.95	.80	.58
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
PROCESSORS							
Bulk	.18	.16	.11	.10	.08	.06	.08
Gallon	0	0	0	.04	.04	.04	.01
Half-gallon	33.78	39.10	44.30	49.02	51.42	54.15	57.95
Quart	64.99	59.65	54.38	49.46	46.79	44.04	40.16
Third-Quart	.07	0	0	0	.02	.12	.38
Pint	.46	.55	.62	.72	.77	.83	.90
Half-pint	.52	.54	.59	.66	.88	.76	.52
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
DISTRIBUTORS							
Half-gallon	46.25	51.32	52.86	55.65	56.51	58.34	60.59
Quart	51.41	45.14	43.35	40.83	39.50	38.54	36.56
Third-Quart	0	0	0	0	.20	.30	.46
Pint	.85	2.02	2.36	1.83	2.11	1.63	1.36
Half-pint	1.49	1.52	1.43	1.69	1.68	1.19	1.03
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

ble 11. FLAVORED MILK: Total, processor, and distributor sales volume distribution by size of container. Mississippi, annual, 1962-1968.

ze of ntainer	1962	1963	1964	1965	1966	1967	1968
				Percent			
				ALL SUPPLIERS			
lk[1/]	.80	7.73	4.71	4.89	6.68	4.64	3.97
lf-gallon	.03	.36	.64	2.21	2.97	3.33	5.45
art	21.32	18.13	17.72	16.39	14.90	14.97	14.07
ird-Quart	.97	.94	.79	1.02	1.07	1.85	3.39
nt	11.31	12.16	14.34	15.37	14.65	15.61	15.96
lf-pint	65.57	60.68	61.80	60.12	59.73	59.60	57.16
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
				PROCESSORS			
lk[1/]	.82	8.19	5.02	4.45	7.19	5.10	4.54
lf-gallon	.02	.32	.68	2.38	3.20	3.66	5.98
art	21.19	17.52	17.25	16.09	14.47	14.72	14.15
ird-Quart	1.01	.92	.72	.76	.52	1.73	3.41
nt	10.76	11.48	13.89	15.07	14.30	15.32	15.76
lf-pint	66.20	61.57	62.44	61.25	60.32	59.47	56.16
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
				DISTRIBUTORS			
lk	.35	.73	.12	10.78	.01	.14	0
lf-gallon	.14	1.00	.10	.08	0	0	1.47
art	23.61	27.39	24.72	20.15	20.44	17.54	13.47
ird-Quart	.15	1.30	1.85	4.16	8.22	3.11	3.21
nt	20.54	22.43	21.06	19.09	19.19	18.51	17.52
lf-pint	55.21	47.15	52.15	45.74	52.14	60.70	64.33
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

1/ Data for years after 1964 include small quantities in gallon containers.

Table 12. LIGHT CREAM AND HALF-AND-HALF[1/] Total, processor, and distributor sales volume distribution by size of container, Mississippi, annual, 1962-1968.

Size of Container	1962	1963	1964	1965	1966	1967	1968
	Percent						
				ALL SUPPLIERS			
Half-gallon	0	0	0	0	0	0	.01
Quart	33.16	33.13	29.91	28.09	25.49	22.94	21.42
Third-Quart	0	0	0	0	0	.12	0
Pint	66.28	66.31	69.61	71.59	74.46	76.76	76.00
Half-pint	.56	.56	.40	.32	.05	.18	2.57
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
				PROCESSORS			
Quart	33.04	33.79	30.50	28.21	25.71	23.37	22.30
Pint	66.50	65.67	69.30	71.54	74.29	76.55	77.58
Half-pint	.46	.54	.20	.25	0	.08	.12
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
				DISTRIBUTORS			
Half-gallon	0	0	.81	0	0	0	.04
Quart	34.45	26.91	24.26	27.02	23.64	19.62	16.22
Third-Quart	0	0	0	0	0	1.07	0
Pint	63.86	72.35	72.58	72.01	75.90	78.37	66.65
Half-pint	1.69	.74	2.35	.97	.46	.94	17.09
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

1/ Excludes tetra-pak.

ble 13. HEAVY CREAM: Total, processor, and distributor sales volume distribution by size of container, Mississippi, annual, 1962-196 .

tainer					1966	1967	
				Percent			
				ALL SUPPLIERS			
k	1.08	1.31	1..	1.60	1.35	1..8	
	12.	10.82	10.90	11.04	10.08	.35	10.31
	.	.32	.03	..	.02	.	.38
f-pint	86.	87.55	87..	85.92	88.	.08	
otal	100.	100.	100.00	100.00	100.00	100.00	100.00
				PROCESSORS			
k	.01		.91	1.77	1..	1..	.81
	12.92		11.38	11.51	10.12	8.92	
	.01	.01	0	. ..	.02	0	2.
lf-pint	87.06	..	87.	85.38	88.	.63	86..
	100.00	.. .00	100.	100.00	100.	100.00	100.00
				[illegible]			
	11.78	14.52	5.79	0	0	0	3.21
	.	1. ..	6.70	6.73	9.76	12.60	1..
	2.89	..	.26	2.40	.01	.	..
lf-pint	80.26	.	87.25	90.87	90.23	..	77.69
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

1/ Includes small quantities in gallon containers.

2/ Includes small quantities in third-quarts.

Table 14. Index numbers of normal month-to-month variation in sales of fluid milk or dairy products, by product class, by dealer size, Mississippi, 19[illegible]-1963.

Item	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Whole milk:												
Gallon	99	100	99	99	98	93	93	98	106	104	107	100
Half-gallon	101	101	100	97	95	100	101	105	101	98	101	105
Quart	97	98	97	97	99	104	103	106	102	101	99	97
Third-quart	93	102	99	95	90	83	89	90	116	144	108	87
Pint	82	88	92	96	99	110	104	112	111	114	105	87
Half-pint	125	135	121	129	100	31	33	35	131	139	130	91
Total sales	103	105	102	102	96	90	91	93	106	106	106	100
Two-percent skim:												
Half-gallon	100	99	111	105	103	90	96	95	100	101	107	93
Regular skim:												
Half-gallon	99	108	107	104	97	97	92	99	94	101	103	99
Quart	100	106	106	105	101	96	92	96	101	104	100	91
Total sales	98	107	107	105	100	97	92	97	96	103	101	95
Buttermilk:												
Half-gallon	105	106	105	101	98	99	93	93	95	99	104	102
Quart	103	101	101	100	100	100	94	98	99	102	103	99
Total sales	103	104	103	101	99	100	93	96	97	101	103	100
Flavored milk:												
Quart	103	109	96	96	92	97	94	103	99	105	103	103
Pint	84	87	90	92	96	106	103	112	114	119	106	91
Half-pint	128	132	119	129	94	24	28	39	138	144	133	92
Total sales	116	120	110	115	93	54	56	66	125	130	121	94
Half-and-half	100	104	105	104	101	100	99	97	94	97	99	100
Light cream	110	93	96	79	99	105	98	99	95	112	112	102
Heavy cream	61	99	110	144	127	94	87	81	75	74	97	131

Table 15. Per capita sales of fluid milk products, Mississippi, [illegible]

Product	[illegible]	[illegible]	6[illegible]	[illegible]6	19[illegible]	[illegible]67	[illegible]
				Half-Pints			
Whole milk	83.7	[illegible]	[illegible]	45.1	[illegible]	[illegible]	[illegible]
Low-fat milk:	(90.7)	(9[illegible])	60.1)	(6[illegible])	(66.[illegible])	(66.3)	(7[illegible])
2% skim	1.1	[illegible]	3.2	[illegible]	7.[illegible]	9.2	[illegible]
Regular skim	6.4	[illegible]	6.7	[illegible]	6.[illegible]	6.3	[illegible]
Buttermilk	22.6	2[illegible]	24.6	2[illegible]	25.[illegible]	5.3	[illegible]
Flavored milk	21.6	2[illegible]	25.6	2[illegible]	27.[illegible]	5.5	[illegible]
Cream products	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
All fluid milk products	[illegible]	2[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 16. Index of per capita sales of fluid milk products, Mississippi, and the U. S., 1962-1968.

Year	Fluid whole milk	Low-fat milk[1/]	Cream[2/]	All products
	1962 = 100			
	MISSISSIPPI			
1962	100	100	100	100
1963	[illegible]	111	98	102
[illegible]	102	116	95	[illegible]
1965	105	126	[illegible]	108
1966	106	129	93	110
1967	[illegible]	128	[illegible]	108
1968	109	[illegible]	91	116
	UNITED STATES			
1962	100	100	100	100
1963	100	106	95	101
[illegible]	100	117	[illegible]	101
1965	[illegible]	126	[illegible]	101
1966	[illegible]	[illegible]	[illegible]	101
1967	[illegible]	[illegible]	[illegible]	99
1968	92	178	[illegible]	99

1/ Includes skim milk, buttermilk, and flavored milk.

2/ Includes all creams, and milk and cream mixtures.

ble 17. WHOLE MILK: Estimates of price and income elasticities, two regression models, Mississippi, 1962-1968

ntainer	ELASTICITY OF: PRICE 1/ Model A	PRICE 1/ Model B	INCOME 1/ Model A	INCOME 1/ Model B
llon	2/1.031	.393	2/ .994	1.420
lf-Gallon	-.804	-.767	.603	.585
art	.364	1.041	-2.188	-2.218
ird-Quart	-1.260	-.025	4.465	5.438
nt	1.125	-2.496	-2.486	1.034
lf-Pint	-.307	.271	.726	.709
tal in lf-Gallon quivalents	-.404	-.420	.289	.291

1/ All estimates statistically significant at the 1 percent level of probability unless otherwise noted.

/ Statistically significant at the 5 percent level of probability.

able 18. SKIM MILK: Estimates of price and income elasticities, two regression models, Mississippi, 1962-1968

roduct and ontainer	ELASTICITY OF: PRICE 1/ Model A	PRICE 1/ Model B	INCOME 1/ Model A	INCOME 1/ Model B
WO-PERCENT SKIM				
Half-Gallon	-2.505	.317	8.428	6.493
EGULAR SKIM				
Half-Gallon	- .868	- .802	2.040	1.913
Quart	- .599	- .506	-1.466	1.543
Total in Half-Gallon quivalents	- .595	- .575	.090	.09

1/ All estimates statistically significant at the 1 percent level of probability.

Table 19. BUTTERMILK: Estimates of price and income elasticities, two regression models, Mississippi, 1962-1968

Container	ELASTICITY OF:			
	PRICE[1/]		INCOME[1/]	
	Model A	Model B	Model A	Model B
Half-Gallon	-1.149	-1.011	2.777	2.629
Quart	- .187	- .098	- .795	- .846
Total in Half-Gallon Equivalents	- .507	- .536	.805	.830

1/ All estimates statistically significant at the 1 percent level of probability.

Table 20. FLAVORED MILK: Estimates of price and income elasticities, two regression models, Mississippi, 1962-1968

Container	ELASTICITY OF:			
	PRICE[1/]		INCOME[1/]	
	Model A	Model B	Model A	Model B
Quart	-2.334	-2.217	.936	.858
Pint	- .170	- .277	2.040	1.881
Half-Pint	-1.619	-1.797	.230	.451
Total in Half-Pint Equivalents	-2.083	-2.085	.818	.803

1/ All estimates statistically significant at the 1 percent level of probability.

le 21. HALF-AND-HALF AND LIGHT CREAM: Estimates of price and income elasticities, two regression models, Mississippi, 1962-1968

duct and tainer	ELASTICITY OF: PRICE[1/] Model A	PRICE[1/] Model B	INCOME[1/] Model A	INCOME[1/] Model B
LF-AND-HALF				
Quart	-1.146	- .759	-2.400	-2.376
Pint	- .310	- .237	- .636	- .651
tal in Pint uivalents	- .473	- .321	-1.090	-1.119
GHT CREAM				
Quart	8.763	10.194	-7.618	-6.491
Half-Pint	4.057	5.948	-12.096	-8.330
tal in Quart uivalents	8.935	9.475	-7.611	-6.543

All estimates statistically significant at the 1 percent level of probability.

Table 22. HEAVY CREAM, SOUR CREAM, YOGURT, AND EGGNOG: Estimates of price and income elasticities two regression models, Mississippi, 1962-1968

Product and Container	ELASTICITY OF: PRICE[1/]		INCOME[1/]	
	Model A	Model B	Model A	Model B
HEAVY CREAM				
Half-Pint	- .605	- .318	- .929	- .867
SOUR CREAM				
Half-Pint	-1.078	- .183	4.203	3.886
YOGURT				
Half-Pint	5.241	3.769	6.836	7.412
EGGNOG				
Quart	-4.210	.179	-4.420	- .309

1/ All estimates statistically significant at the 1 percent level of probability.

ppendix Table 1. Fluid milk products included in specified product classes, Mississippi, 1962-1968

roduct class	Product
hole milk	Regular milk Military milk Homogenized milk Premium milk
-Percent skim milk	2-Percent skim milk with solids added 2-Percent skim milk without solids added
kim milk	Skim milk Fortified skim milk
uttermilk	Buttermilk Bulgarian buttermilk Flake buttermilk
lavored milk	Flavored milk Flavored drink Military flavored milk
ream	Half-and-half Light cream
eavy cream	Heavy cream
ther products	Tetra-pak Sour cream Sour cream mix Other cream Yogurt Eggnog Other mixes Other products

Appendix Table 7. TOTAL FLUID MILK SALES: Distribution by product, by year, Mississippi, 1962-1968.

Product	Year						
	1962	1963	1964	1965	1966	1967	1968
	Thousand pounds						
Whole milk	285,643.9	290,849.4	296,396.6	308,515.7	313,527.7	309,954.1	324,006.4
Homogenized milk	(269,951.0)	(265,009.9)	(275,445.0)	(267,615.4)	(261,323.6)	(257,135.3)	(285,605.4)
Other whole milk	(15,692.9)	(25,829.5)	(22,951.6)	(40,900.3)	(52,204.1)	(52,818.8)	(38,401.0)
2-Percent skim milk	1,403.7	2,628.1	4,046.9	5,905.8	8,877.0	11,755.2	16,176.9
Regular skim milk	7,761.0	7,960.4	8,377.3	8,999.2	8,169.5	8,019.1	7,401.4
Buttermilk	27,582.9	28,863.9	30,690.5	32,374.3	32,445.6	32,218.0	34,738.0
Flavored milk	26,437.4	31,404.7	31,961.3	34,721.2	35,165.6	32,476.0	37,340.4
Cream	3,266.5	3,185.2	3,024.1	2,882.3	2,732.7	2,413.4	2,307.1
Heavy cream	668.9	618.7	631.8	606.1	594.7	565.1	539.7
Other products	660.3	777.7	803.6	962.1	1,130.4	1,337.9	1,512.9
Total	353,460.2	366,298.2	377,394.1	394,986.1	402,643.9	398,743.8	426,042.8

Source: Appendix Tables 5 and 6.

Appendix Table 3. TOTAL PROCESSOR SALES: Distribution by product, by year, Mississippi, 1962-1968. 1/

Product	Year						
	1962	1963	1964	1965	1966	1967	1968
	Thousand pounds						
Whole milk	272,239.1	266,774.0	280,927.8	288,841.7	293,450.3	285,402.5	292,381.7
Homogenized milk	(256,788.1)	(241,735.1)	(253,210.4)	(247,668.4)	(240,890.3)	(232,511.1)	(254,303.0)
Other whole milk	(15,451.0)	(25,038.9)	(22,717.4)	(41,173.3)	(52,560.0)	(52,891.4)	(38,078.7)
2-Percent skim milk	1,413.0	2,632.8	3,975.4	5,765.6	8,504.0	11,392.9	15,071.6
Regular skim milk	7,410.0	7,066.5	7,667.7	7,930.6	7,164.5	6,717.1	6,163.2
Buttermilk	26,330.7	27,289.7	29,239.9	30,535.7	30,652.3	30,140.6	31,950.1
Flavored milk	25,560.4	29,905.0	30,792.7	32,899.9	33,192.3	36,024.3	33,437.9
Cream	3,078.4	2,936.4	2,810.7	2,657.2	2,515.0	2,178.6	2,011.3
Heavy cream	626.5	571.7	575.5	569.2	532.5	501.3	473.6
Other products	550.5	603.3	684.3	810.4	976.8	1,167.6	1,344.6
Total	337,208.6	337,779.4	356,674.0	370,010.3	376,987.7	367,524.8	382,834.0

Source: Appendix Tables 4 and 5.

1/ Includes sales by Mississippi processors to customers in other States.

Appendix Table 4. PROCESSOR OUT-OF-STATE SALES: Distribution by product, by year, Mississippi, 1962-1968.

Product	Year						
	1962	1963	1964	1965	1966	1967	1968
	Thousand pounds						
Whole milk	7,098.3	6,966.7	8,440.0	8,470.7	8,857.4	7,921.8	7,881.1
Homogenized milk	(7,098.3)	(6,966.7)	(8,346.8)	(8,067.7)	(8,444.1)	(7,462.5)	(7,416.8)
Other whole milk	(0.0)	(0.0)	(93.2)	(403.0)	(413.3)	(459.3)	(464.3)
2-Percent skim milk	10.1	4.7	33.3	0.0	0.0	62.8	71.3
Regular skim milk	192.9	177.9	402.2	316.0	368.2	331.9	199.0
Buttermilk	777.0	853.9	1,062.4	892.0	944.6	933.2	1,029.6
Flavored milk	591.7	446.6	853.5	748.4	550.9	494.1	504.6
Cream	76.9	55.9	71.6	66.9	64.5	45.0	37.4
Heavy cream	4.7	6.9	7.1	4.0	1.9	2.0	2.3
Other products	9.1	6.8	15.3	10.5	7.0	8.2	18.5

Appendix Table 5. PROCESSOR IN-STATE SALES: Distribution by product, by year, Mississippi, 1962-1968.

Product	Year						
	1962	1963	1964	1965	1966	1967	1968
	Thousand pounds						
Whole milk	265,140.8	259,807.3	272,487.8	280,371.0	284,592.9	277,480.7	284,500.6
Homogenized milk	(249,689.8)	(234,768.4)	(249,863.4)	(239,600.7)	(232,446.2)	(225,048.6)	(246,886.2)
Other whole milk	(15,451.0)	(25,038.9)	(22,624.4)	(40,770.3)	(52,146.7)	(52,432.1)	(37,614.4)
2-Percent skim milk	1,402.9	2,628.1	3,942.1	5,765.6	8,504.0	11,370.1	15,000.3
Regular skim milk	7,217.1	6,888.6	7,265.5	7,612.6	6,796.3	6,385.2	5,964.2
Buttermilk	25,553.7	26,435.8	28,170.5	29,676.7	29,707.7	29,207.4	30,920.5
Flavored milk	24,968.7	29,458.4	29,939.2	32,151.5	32,641.4	29,530.1	32,933.3
Cream	3,001.5	2,880.5	2,738.1	2,590.3	2,450.5	2,133.6	1,973.9
Heavy cream	621.8	564.8	568.4	565.2	529.6	499.3	470.8
Other products	541.4	596.5	669.0	799.9	969.8	1,159.4	1,326.1
Total	328,447.9	329,260.0	345,780.6	359,532.8	366,192.2	357,765.8	373,089.7

Appendix Table 6. DISTRIBUTOR SALES: Distribution by product, by year, Mississippi, 1962-1968.

Product	Year						
	1962	1963	1964	1965	1966	1967	1968
	Thousand pounds						
Whole milk	20,503.1	31,052.1	25,908.8	28,144.7	28,934.8	32,473.4	39,505.8
Homogenized milk	(20,262.1)	(30,261.5)	(25,581.6)	(28,014.7)	(28,777.4)	(32,086.7)	(38,719.2)
Other whole milk	(241.0)	(790.6)	(327.2)	(130.0)	(157.4)	(386.7)	(786.6)
2-Percent skim milk	0.8	0.0	105.9	139.6	373.0	388.1	1,176.6
Regular skim milk	563.9	1,071.8	1,111.8	1,386.6	1,373.2	1,633.9	1,457.2
Buttermilk	2,029.2	2,428.1	2,520.0	2,697.6	2,737.9	3,010.6	3,817.5
Flavored milk	1,468.7	1,946.3	1,982.0	2,569.7	2,524.2	2,947.9	4,407.1
Cream	265.0	304.7	286.0	292.0	282.2	279.8	333.2
Heavy cream	62.1	53.9	64.4	60.9	65.1	65.8	68.9
Other products	119.5	181.2	134.6	162.2	160.6	178.5	186.8
Total	25,012.3	37,038.1	32,113.5	35,453.3	36,451.0	40,978.0	50,953.1

1971 Crop and Fertilizer Recommendations For Mississippi

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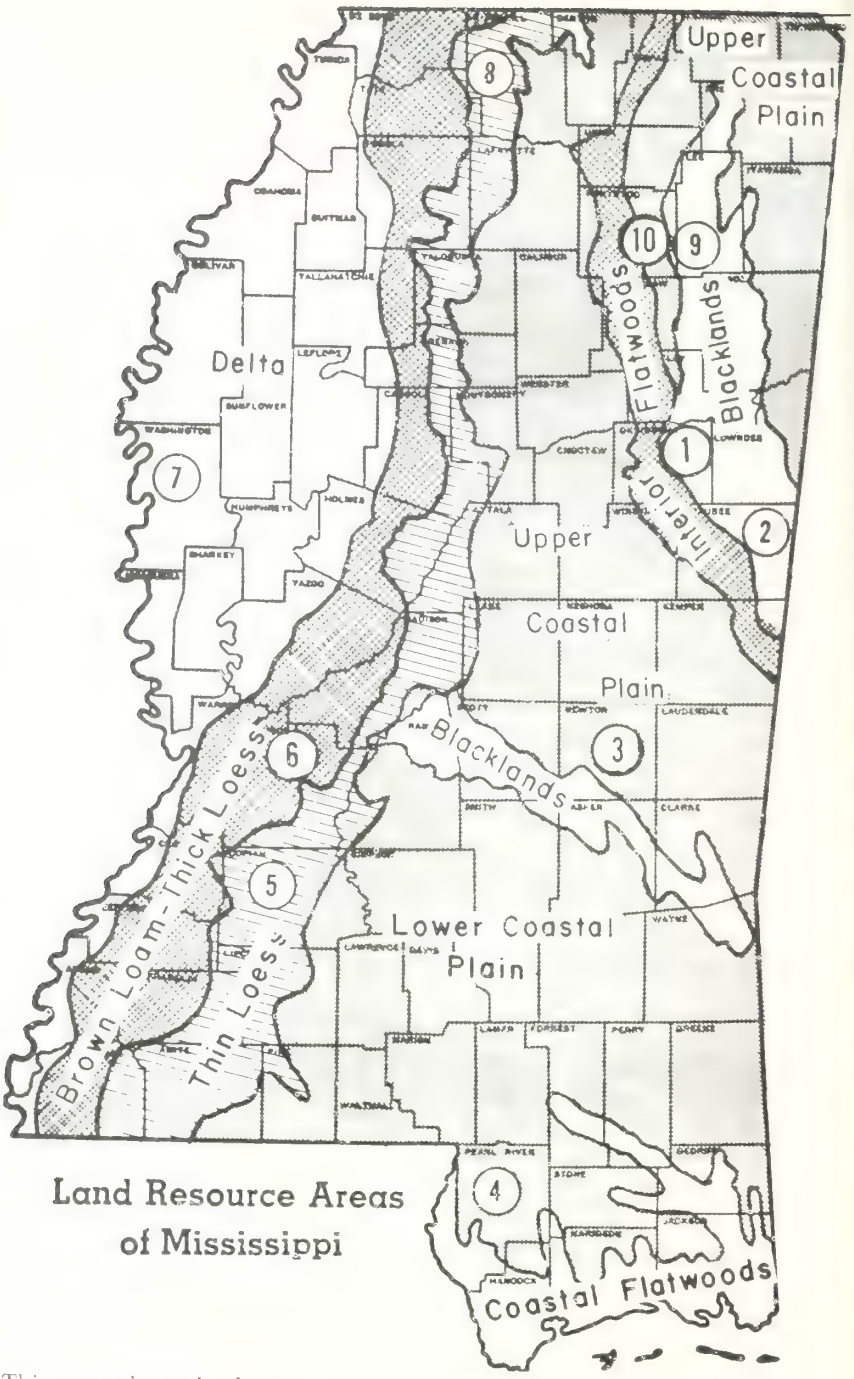

Land Resource Areas of Mississippi

This map shows land resource areas of the state and how Experiment Stati locations fit into them. Number 1 is the main station at State College. Branch statio are: 2 Brooksville, 3 Newton, 4 Poplarville, 5 Crystal Springs, 6 Raymond, Stoneville, 8 Holly Springs, 9 Verona, and 10 Pontotoc.

CROP AND FERTILIZER RECOMMENDATIONS FOR MISSISSIPPI

rop and fertilizer recommendations
a made annually by the Mississippi
Aicultural and Forestry Experiment
Station. These recommendations
rporate the latest research findings at
Ste College and the Branch Experiment
Stions. Included is information on
rieties and fertilization and seeding
ctices for crops commonly grown in
l state, as well as information on lawns
l other turf areas.

Because of varying soil and weather
nditions and other local factors, no
ngle crop variety or fertilizer
ommendation will fit the entire state
rfectly; nonetheless, these general
ommendations are useful guides for
op production. Of course these
ommendations assume that other good
ming practices will be followed.

f more specific information is needed,
may be obtained from the Extension
rvice, the Experiment Station, your
unty Agent, or other trained
ricultural workers in your locality.

Soil Testing Service

The farmer gets maximum profit from
rtilizer only when the right kind and
nount are used on each field.

Through the Soil Testing Department
the Cooperative Extension Service
ery farmer can get this information as
ell as information on liming practices.
rthermore, the Soil Testing Service
akes recommendations for
xceptionally high production goals
hich may not be provided for in the
neral recommendations.

Soil testing is a free service. Soil sample
oxes, mailing cartons, and instructions
r collecting samples are available in
ch county agent's office and the offices
f other agricultural agencies.

Plant Nutrients

Plant nutrients can be divided into two
roups: (1) Those elements used by crops
n relatively large amounts, the
nacronutrients; and (2) those needed in
very small amounts, the micronutrients.

The first group includes nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur. These are usually subdivided into the primary fertilizer nutrients – nitrogen, phosphorus, and potassium – and the secondary fertilizer nutrients – calcium, magnesium, and sulfur. The primary nutrients are applied to crops either as materials or as mixed fertilizers. A fertilizer material usually contains only one fertilizer nutrient. Some examples of fertilizer materials are listed below:

Material	Total Nitrogen N
Ammonium nitrate	33.5%
Anhydrous Ammonia	82 %
Nitrate of soda	16 %
	Available Phosphate (P_2O_5)
Superphosphate	18 to 20%
	Available Potash (K_2O)
Muriate of potash	60 %

Mixed fertilizers contain two or more of the fertilizer nutrients. Each fertilizer bag is labeled with a set of numbers to show how much of each nutrient it contains. The first number shows the percentage of nitrogen (N), the second percentage available phosphate (P_2O_5), and the third the percentage water-soluble potash (K_2O). One hundred pounds of a 5-10-10 fertilizer thus contains 5 lbs. of total N., 10 lbs. of available P_2O_5, and 10 lbs. of available K_2O. Fertilizer ratio refers to the relative amounts of these nutrients. The fertilizer grade gives the guaranteed amounts of each fertilizer nutrient as a percentage. For example 8-8-8 and 10-10-10 are two

different grades in a 1-1-1 ratio. Similarly, 6-8-8 and 9-12-12 are two grades in a 3-4-4 ratio. Materials such as ordinary superphosphate may be labeled as 0-20-0.

At present fertilizer nutrients are either expressed as the oxide, phosphorus as phosphorus pentoxide (P_2O_5), or as the element, nitrogen as N, but there is a trend toward expressing all fertilizer nutrients on the elemental basis. Accordingly, phosphate would be expressed as (P) and potash as (K) by using the chemical symbols for phosphorus and potassium, respectively. The primary "fertilizer nutrients" expressed on the elemental basis would then be shown as N-P-K on the fertilizer bag. Some fertilizers are labeled both ways to familiarize consumers with the new labeling trend. When labeled on an elemental basis a 10-20-20 (N-P_2O_5-K_2O) would become a 10-8.2-16.5 (N-P-K). The conversion factors for potash are: $K_2O \times 0.83 = K$; $K \times 1.21 = K_2O$. The conversion factor for phosphate are: $P_2O_5 \times 0.436 = P$; $P \times 2.29 = P_2O_5$. Only the method of labeling is changed not the plant nutrient value of the fertilizer.

For the most part fertilizer recommendations are given in this bulletin as pounds of N, P_2O_5, and K_2O needed per acre. Usually the farmer will have a choice of more than one fertilizer grade. For example, 48 lbs. N, 48 lbs. P_2O_5, and 48 lbs. K_2O may be supplied with 600 lbs. of 8-8-8 or 400 lbs. of 12-12-12. Since some deviation from the general recommendation does not affect net profit greatly, it is not necessary to apply exactly the amount of N, P_2O_5, or K_2O as indicated.

Both the need for and the presence of the secondary nutrients in fertilizers is variable. Research has shown that sulfur deficiency is likely to occur on soils in the Hill Section when sulfur-free fertilizers are used. Accordingly, sulfur is recommended for crop production in this area especially for cotton and legumes. A convenient and economical way to get the sulfur is to use mixed fertilizers that contain sulfur. Most solid mixed fertilizers sold in Mississippi contain adequate sulfur, but most liquid mixed fertilizers do not unless special provision is made for the addition of sulfur.

Scattered instances of sulfur deficiency have been observed in the Delta Area. These deficiencies have been associated with land leveling and very sandy soils that are low in organic matter. Since mixed fertilizers are less commonly used in this area, other sources of sulfur may be more economical or convenient to apply. Sources of sulfur that may be used include gypsum, elemental sulfur, ammonium sulfate, and ordinary superphosphate.

Calcium and magnesium are usually applied to soils as agricultural limestone although a major objective of liming is to neutralize soil acidity. A more complete discussion of liming is given elsewhere. On soils needing magnesium but not requiring lime, the addition of a water-soluble source of magnesium to mixed fertilizers is a very convenient method of applying the magnesium.

The second group of nutrients is referred to variously as "trace elements," "minor elements," and "micronutrients." They are needed by crops in very small amounts. Included are iron, manganese, zinc, copper, boron, molybdenum and chlorine. Thus far, only three (zinc, boron, and molybdenum) of these have been found to be deficient to an appreciable extent for crop production in Mississippi. These deficiencies have not occurred on all crops and have been restricted almost entirely to the Hill Section. Specific recommendations for micronutrients are given later for crops which need them.

Solid or Liquid Fertilizers

Mixed fertilizers are available in both solid and liquid forms. Liquid fertilizers have given, or would be expected to give, excellent results in most cases, but they are no more effective than many, if not most, solid mixed fertilizers.

The inferiority of some solid mixed

izers to liquid mixed fertilizers and her solids can be attributed primarily he phosphate component of these tilizers. Only highly water soluble sphates are, of necessity, used in the nulation of liquid mixed fertilizers, the water solubility as well as other acteristics of the phosphate materials olid mixed fertilizer may vary widely. highly water soluble phosphates are effective fertilizers but all those of water solubility are not.

olid mixed fertilizers formulated with monimum phosphates and -ammoniated superphosphate contain very high percentage of their sphorus in a water-soluble form and just as effective as liquid mixed ilizers. Ammoniation of ordinary and centrated superphosphates to add ogen during the formulation of mixed ilizers, which is a common practice, verts some of the highly effective er-soluble mono-calcium phosphate to er-insoluble calcium phosphate some which may be somewhat less effective crop production. This is particularly e with ordinary superphosphate (20%) cause of the formation of an atite-like calcium phosphate, the ntity of which increases progressively h increasing ammoniation. In a sense w rock phosphate is formed. nsequently, mixed fertilizers mulated from highly ammoniated inary superphosphate are not as ecitve as liquid mixed fertilizer, or er high quality solids. Unfortunately, st of the phosphorus in the apatite-like osphates formed upon ammoniation of linary superphosphate is determined to "available" by the chemical method rently used for control purposes.

With the sources of phosphorus mmonly used in the formulation of xed fertilizers in Mississippi farmers are sonably assured of good results if 50 60 percent of the "available" osphorus is also water-soluble. Some nufacturers give the water-soluble osphorus content of their fertilizers though this is not required by law.

A substantial amount of nitrogen in liquid mixed fertilizers is derived from urea and/or ammonium nitrate. As will be indicated later nitrogen solutions containing either urea or urea and ammonium nitrate have been much less effective for surface application to summer pastures than either solid urea or ammonium nitrate. Therefore, liquid complete fertilizers would not be expected to be as effective for summer pastures as solid complete (NPK) fertilizers.

Soil pH and Liming

Excessive soil acidity and associated factors reduce crop yields. A recent summary of soil test results by the Cooperative Extension Soil Testing Department showed that some 70 percent of the soils tested needed lime for legumes and 40 percent for non-legumes.

The degree of acidity or alkalinity of a soil is expressed by its pH; values below 7.0 indicate an acid soil, above 7.0 an alkaline soil. Soil reaction, or pH, affects the availability of some of the more important plant nutrients in the soil. Phosphate is much less available in very acid soils than in slightly acid to mildly alkaline soils. In very strongly acid soils (pH below 5.0) certain elements such as manganese and aluminum may become available in such quantities as to be toxic to plants. On the other hand micronutrients such as iron, manganese, boron and zinc rapidly become less available as the pH of the soil is increased above 6.0. This is one reason why one must not overlime. Experience has shown that overliming injury in Mississippi is very likely to be associated with deficiencies of boron and zinc. In the case of cotton and legumes, it is very likely to be due to boron deficiency and with corn, and perhaps other grasses, to zinc deficiency.

Soils with a pH of 6.0 to 7.0 are well supplied with lime. If the pH is less than 5.0, the soil is very strongly acid and is

extremely deficient in lime. Most non-legumes grow best at soil pH values of 5.5 and above while most legumes do best if the pH is maintained above 6.0. Alfalfa does best at soil pH values above 6.5.

The amount of lime required to raise the pH of the soil to a desired value depends both on the initial pH and the lime holding capacity of the soil. For soils of Mississippi having a pH of 5.5 or slightly below, the application of 3000 pounds of lime per acre to sandy loam soils, 5000 or 6000 pounds to loam and silt loam soils, and 7000 to 9000 pounds to clay loam and clay soils, respectively, has been satisfactory in correcting lime deficiency for legumes. Since about two-thirds of the soils of the state have pH values of 5.5 or above, and 95% above 5.0, these rates of lime would bring the pH of most of the soils of the state within the range that is favorable for legumes. However, some soils need more, some less, and some need no lime. Therefore, the best practice is to test the soils for pH and lime requirement and apply lime as needed to maintain the pH within the desired range.

Lime is lost naturally from the soil by crop removal and by leaching. The use of acid forming sources of nitrogen and the turning under of legumes as soil builders accelerates leaching losses. For example, 100 pounds of nitrogen from such sources as ammonium nitrate, anhydrous ammonia and urea will cause the loss of calcium and other bases equal to about 200 pounds of lime. When applied annually at this rate, the loss would amount to one ton of lime every ten years due to fertilizer alone. Because of these losses, soils need to be limed periodically.

Generally, on sandy loam, loam and silt loam soils a maintenance application of 2000 to 3000 pounds of lime per acre once every 5 to 7 years is required for legumes and for non-legumes fertilized with nitrogen as recommended. On clay loam and clay soils less frequent but larger applications are required. Althoi lime may be needed badly on some s for non-legumes, the deficiency is widespread enough to warrant a gen recommendation for rates in excess maintenance requirements for these cr in the absence of a soil test. Areas go into permanent grass sod should rece the initial maintenance application lime prior to establishment. Subsequ maintenance applications may be appl to the surface.

Except for the dark upland soils a the bottom soils of the Northe Blackland area, maintenance applicati should be made to soils that have r been limed during the past 5 to 7 yea

The principal liming materials availa in Mississippi are ground calcic a dolomitic limestones, crushed chalk marl from Mississippi deposits and ba slag. Calcic limestones contain calci carbonate while dolomitic limesto contain both calcium and magnesi carbonates. Liming materials fr Mississippi deposits contain calci carbonate only. Basic slag, a mater containing a minimum of 6 percent P_2 and the equivalent of about 60 perce lime should be used only where both t lime and phosphate are needed. The c of its use as a liming material only prohibitive.

Research has shown that all of the materials are very effective in neutralizi soil acidity providing the calcic a dolomitic limestones are finely groun Particles not passing a 40-mesh (40 hol per linear inch) are not very effective neutralizing soil acidity. For this reas 90 to 100 percent of calcic and dolomit limestones should pass a 10-mesh scre and 50 percent a 100-mesh scree Particle size is not as important in th case of chalk because it contains cla impurity which causes the particles t break down within the soil. It must b crushed fine enough, however, to b spread uniformly.

Generally, the Delta and Deep Loe soil areas are abundantly supplied wit

gnesium, therefore, dolomitic lime is no advantage in these areas. In the er soil areas of the state, however, gnesium levels tend to be lower and a ing material containing considerable gnesium, such as dolomitic lime, uld be used; particularly in the rtheast Blacklands.

or best results lime should be mixed roughly with the top six to eight hes of the soil. However, depending on texture of the soil, a maintenance plication of 1000 to 2000 pounds per e may be made as a surface application permanent pastures, or other manent sods.

When to Fertilize

ollowing their application to the soil, tilizers become less available to plants. is occurs because they may be lost by aching and volatilization or be verted to less available forms within soil. Nitrogen is both leached and atilized. Potassium is leached from me soils but phosphate is not. But osphate is changed to less available rms.

ertilizers may contain nitrate or monium nitrogen, or both, or other rms (urea and Cyanamide) that are anged rather rapidly to ammonium hen applied to the soil. Nitrate salts und in fertilizers and in soils are highly luble in water and are not retained emically by the soil. Therefore, they main in solution and move freely with e soil water being easily leached from e root zone, particularly on sandy am, loam and silt loam soils, or other ils where water percolates readily. nder water-logged conditions, which are ore likely in clay soils, nitrates may be anged by soil bacteria to gaseous trogen (denitrified) which escapes into e atmosphere. Ammonium nitrogen is ot denitrified nor is it easily leached, but does not persist for long periods. It is anged (nitrified) by soil bacteria to trate.

Since nitrogenous fertilizers are not held in soils for long periods they are used more efficiently for crop production when applied at or near planting time or during the growing season.

Phosphate fertilizers are not lost by leaching because they react with certain soil constituents to become only sparingly soluble in water. In acid soils the reaction is mostly with iron and aluminum but in neutral and alkaline soils calcium phosphates of very low water solubility also are formed. The soil-phosphate reaction products themselves become less available with time but the process is more rapid in acid soils, particularly at pH values below 6.0.

The formation in soils of sparingly soluble phosphates and their subsequent reduction in availability to plants collectively is referred to as "phosphate fixation." Because of fixation, greater efficiency generally is obtained from annual, seasonal applications of phosphate fertilizer than from less frequent or offseason applications, especially on moderately to strongly acid soils. Accordingly, it is usually suggested that phosphate fertilizers be applied at or just prior to planting, or near the beginning of the growing period for perennial crops.

Unlike phosphate, the effectiveness of potash fertilizers is not reduced appreciably by fixation in Mississippi soils. But there is some loss by leaching, particularly from the more sandy soils. Where leaching is significant annual, seasonal applications result in more efficient utilization of potash than less frequent or off-season applications. Because of uptake in excess of need and its removal in the harvested crop, annual and sometimes split applications of potash are necessary for optimum efficiency for forage crops.

Because of rising costs and labor shortages, farmers increasingly are more interested in greater mechanization, custom services and in spreading their work load to increase efficiency. One way of spreading the work load is to increase

land preparation and application of fertilizers in the fall where feasible for spring-seeded crops.

Fall application of nitrogen for spring-seeded crops is not practical in Mississippi but there are opportunities for fall application of phosphate and potash where fall plowing is practiced. Because of previous fertilization or native fertility, levels of available phosphate and potash in much of our good crop land now are at the point where only small increases in yield, if any, are obtained each year from the application of these fertilizers. At these fertility levels, which a soil test will show, no more than maintenance rates are needed for maximum economic returns from fertilizer. Under such conditions the crop yield is affected only slightly, if at all, by the time or method of application of the fertilizer. Here there is an opportunity for fall application of phosphate and potash in connection with fall plowing.

Fall application of phosphate and potash need not be restricted to conditions where maintenance rates are required. On slightly acid to alkaline clay and clay loam soils of the Blackland Area that are very deficient in phosphorus, fall application of phosphate has been just as effective as spring application. Similar results would be expected on other soils having similar native pH values. Top yields also can result from fall application of phosphate or other soils that are low in available phosphorus; but, because of fixation, a higher rate would be needed in the fall than in the spring, especially on acid soils having a pH below 6.0. Eventually, though, the phosphate would build up in these very deficient soils to the point that a maintenance rate would be sufficient either for fall or spring application.

Except for leaching losses, potash applied in the fall for spring-seeded crops would be expected to be about as effective as that applied in the spring. Leaching losses are not particularly significant on clay and clay loam so But, as indicated before, leaching los do occur on the lighter soils. Leach losses are reduced by broadcasting fertilizer and maintaining the soil above 6.0 by liming. With broadc application on properly limed so substantial losses by leaching probal would not occur except on light san soils. Potash losses by leaching can compensated by higher rates application which might be an accepta alternative to spring application in so cases.

How to Fertilize

To obtain maximum utilization fertilizers, the two components availability, namely chemical a positional, must be optimize concurrently. Chemical availability refe to the capacity of the fertilizer and soil-reaction products to supply nutrien to plants. Positional availability refers the location of the fertilizer with respe to the plant roots. For example, fertiliz placed in the soil a foot or so from t row is positionally unavailable to seedli plants.

The chemical availability of nitrog and potassium in fertilizers usually is n affected greatly by degree of contact wi the soil. However, the effectiveness highly reactive phosphates is protected b reducing their contact with the soil whic slows the rate of phosphate fixation. Th may be dome either by band placemer in the soil or by granulation of th fertilizer at the factory. Since most soli fertilizers sold in Mississippi a granulated or pelletized, method application has a greater effect o positional than on chemical availability

To assure effective position availability fertilizers should be placed s as to be intercepted by plant roots at a appropriate time, or be moved to plan roots with soil water. As plants grow an extend their roots both horizonally an vertically the volume of soil from whic nutrients may be absorbed is increased

nsequently, fertilizers that are itionally unavailable during early plant wth may be available later.

iosphate does not move appreciably soils and the movement of potash is iewhat limited, especially on soils of lium to fine texture. Therefore, these ilizers must be placed so as to be rcepted by plant roots. For l-seeded and row crops they should be ed in the soil deep enough to be in moist soil where plants feed as they w. For such crops, surface application shallow incorporation, as by disking, ld be expected to give inferior results ause of poor positional availability.

itrogen as nitrate moves with the soil ter to plant roots. Its over-all ciency is not affected greatly by ree of concentration or its location hin the root zone except that enough ogen should be positionally available optimum growth of young plants.

itrogenous fertilizers applied to the face of dry soils remain positionally available for the most part until solved and moved down into the root e by percolating water. Before monium nitrogen in fertilizers is ved down into the root zone, it must changed (nitrified) by soil bacteria to rate, a process requiring two to four eks for completion in moist soil during rm seasons. Unfavorable positional ilability is avoided by applying rogenous fertilizers far enough in vance of the necessary transformation l movement into the root zone by nfall to occur by the time the nitrogen eeded by the crop.

Localized concentration of immobile tilizer nutrients, such as phosphorus l potassium, near the row or drill, as ults from band application, provides a y favorable opportunity for early rception by plant roots as well as for ensive root development within the tilized zone later, a condition which ntributes to optimum fertilizer iciency. An outstanding benefit from osphorus is its favorable influence on the early growth and development of plants. This effect is enhanced by localized placement of fertilizer near the row.

Although maximum efficiency of phosphate and potash is usually obtained by band placement for row crop and drill-seeded crops, top yields can be obtained with broadcast application of these fertilizers. But on soils that are rather low in phosphate and potash, higher rates are needed for broadcast than for band application to obtain the same increase in yield. This is especially true where the fertilizer is incorporated by shallow disking instead of being plowed under.

Because of accumulation from previous applications, only a small percentage of the row-crop land previously cropped to cotton and fertilized as recommended over a long period would be expected to be so low in phosphate and potash as to require an appreciable increase in the recommended rate to obtain essentially the same yields when broadcast as when banded beside the row.

A hazard of localized placement of the fertilizers near the row is salt injury to seeds and seedlings resulting in poor stands and stunted growth. Since fertilizer salts, such as nitrates and chlorides, move mostly upward and downward with soil water rather than laterally by diffusion, salt injury can be avoided by placing the fertilizer to the side of rather than beneath the seed. The distance of separation required depends upon the kind of fertilizer and the rate of application. For recommended rates of phosphate and potash and up to about 40 pounds of nitrogen per acre, the minimum distance of separation should be 3 to 4 inches to the side of and 3 to 4 inches below the seed. With higher rates of nitrogen or potash both the horizontal and vertical distances between seed and fertilizer should be increased, or the fertilizer should be broadcast and plowed under.

Surface application of phosphate and potash to sod crops is more effective than for row crops. This is due in part to the development and persistence of plant roots near the surface. Because it is both convenient and effective this method of application is recommended for maintenance fertilizers on perennial, close-growing crops.

Solid sources of nitrogen are much more effective for surface application to summer pastures than are the urea-ammonium nitrate solutions such as N-Sol-32 and uran. Thus far, these solutions have ranged in effectiveness from 55 to 75 percent of that of solid ammonium nitrate. Urea solid has been equal to ammonium nitrate when applied in June, but when applied a month earlier its relative value was about 85 percent of that of ammonium nitrate.

Foliar Feeding

Plants absorb and utilize nutrients applied in solution to their leaves and if a deficiency exists, yields and/or quality may be improved by foliar application. Because they are required in such small amounts, very dilute nutrient salt solutions of the micronutrient (trace elements) may be used quite satisfactorily as foliar sprays to correct deficiencies without injury (burning) to foliage. In some areas foliar feeding of t elements has become a somew standard practice for crop product Frequently, micronutrients are app conveniently and inexpensively al with insecticides and fungicides. A typ example is the application of boron cotton with the insecticide. Howeve far, under Mississippi conditions t appears to be no need for both foliar soil application of micronutrients wh they are needed for crop production.

The primary (nitrogen, phosphorus, potassium) and the secondary (sul calcium, and magnesium) nutrients, absorbed in relatively large quantities crops. Thus, to supply a substantial p of the total requirement of t nutrients without burning the leaves plants would require several applicati of rather dilute solutions during growing season. Therefore, foliar feed of these nutrients is not as feasible foliar feeding of the micronutrie Increases in the yield of cotton have b obtained in Mississippi under cert conditions from foliar feeding of primary nutrients, but it has not b shown so far to be a desirable economical alternative to soil applicat of these nutrients. Therefore, fo feeding is not now recommend routinely in lieu of or as a supplemen soil application of plant nutrient.

Recommendations for Major Field Crops

CORN

Varieties: Detailed results of variety trials are published annually in Mississippi Farm Research. Only those varieties that are resistant to Southern Corn leaf blight should be planted. Plants from seed produced on normal (N) cytoplasm should be tolerant to Southern Corn leaf blight that caused serious losses in 1970. Plants from seed produced on Texas (T) male sterile cytoplasm will be susceptible to this disease. Seed sold in 1971 will be labeled with the percentage of (N) and/or (T) cytoplasm in the bag. If hybrid s produced on normal (N) cytoplasm is available for planting in 1971, cons Extension personnel for information expected results from blends, F open-pollinated varieties, and other s corn.

Seeding Dates and Rates and La Selection: Plant in North Mississippi fr April 1 to April 25, in North Cent Mississippi from March 25 to April 20 South Central Mississippi from March 5 to April 15, and in South Mississippi fr

ruary 25 to March 15.

rn should be planted on deep to erately deep soil with fair to good ace drainage. Steep, droughty, and led hillsides are not well suited to n.

lands should be adjusted to expected age yield and in Mississippi should e from 12,000 to 18,000 plants per . It is desirable to use the minimum d that will give near maximum yield a given set of conditions. A good rule thumb is to provide about 130 plants each bushel of expected yield. For mple, with an average expected yield 120 bushels per acre, the stand should between 15,000 and 16,000 plants. lower yields the stand would be uced proportionately; but, because of advantage of shading in weed control should never be below 12,000 plants acre. On the more productive soils, h as bottomland soils and deep, nearly el to gentle rolling upland soils, average lds of 80 to 120 bushels per acre sonably should be expected with good ltural practices including proper tilization.

Fertilization—Hill and Delta Foothill Areas: Soils of the Hill and Delta - Foothill Area generally require a mplete fertilizer for corn. Soils should limed to maintain the pH above 5.5. casionally, following the application of me, zinc deficiency may be countered, especially on soils of edium to coarse texture. When this curs, a mixed fertilizer which contains ough zinc to give 2-3 pounds per acre ould be used for two to three years. No her micronutrient deficiencies have en observed in corn.

Time: Apply all of the phosphate and otash before planting. Nitrogen may be plied before planting or in split plications: one-fourth to one-third efore planting and the remainder as a de dressing by the time the corn is knee igh.

Rate: Apply 120 to 250 pounds of nitrogen and 40 to 70 pounds each of phosphate (P_2O_5) and potash (K_2O) in approximately 3-1-1 ratio, but adjust the rate to the expected average yield. For an expected yield of 120 bushels per acre the rate is 210 lbs. N, 70 lbs. P_2O_5, 70 lbs. K_2O. At lower yields the rate is reduced proportionately, being 162 lbs. N, 54 lbs. P_2O_5 54 lbs. K_2O per acre for a 100-bushel yield and 120 lbs. N, 40 lbs. P_2O_5 40 K_2O for one of 80 bushels. If corn is grown continuously for silage for several years, apply 50 to 60 lbs. of phosphate and 100 to 120 pounds of potash per acre in a 1:2 ratio.

For broadcasted applications of phosphate and potash, the rate should be 60 to 80 pounds of each per acre on soils known to be very deficient in these nutrients.

Method: All of the phosphate and potash and up to 40 pounds of nitrogen per acre may be placed in a band located 3 to 4 inches to one side and 3 to 4 inches below the seed. The remaining nitrogen may be drilled at least 6 inches from the row, broadcast, or applied later as a side dressing. All or part of the nitrogen may be broadcast as a mixture with phosphate and potash, however, the fertilizer should be plowed down as should all broadcast applications of phosphate and potash. Preplant applications of anhydrous ammonia should be placed at least 6 inches to the side of and 6 inches below the seed.

Place side-dress applications of nitrogen a foot or more from the row, nonpressure solutions and solid sources at a depth of 4 inches and anhydrous ammonia at a depth of 6 inches. Surface, sidedress, application of solid sources and nonpressure solutions is almost as effective as in-soil placement.

Fertilization – Delta Area: For soils in this area, only nitrogen is needed generally for top production. Soil test for phosphate and potash needs.

Time: Nitrogen may be applied just prior to planting or in split application: one-half at or before planting and the rest as a side-dressing before the corn is knee high.

Rate: 120 to 250 pounds of nitrogen per acre, increasing the rate as the expected yield increases.

Method: Place preplant applications of nitrogen 6 or more inches from the drill row, non-pressure solutions and solid sources at a depth of 4 or more inches and anhydrous ammonia at a depth of 6 inches below the level of the seed. Side dress applications of nitrogen should be placed 1 foot or more from the row, non-pressure solution and solid at a depth of 4 inches and anhydrous ammonia at a depth of 6 inches. Surface application of solid sources and non-pressure solutions is only slightly less effective than in-soil placement.

COTTON IN THE DELTA

Varieties: Results of variety tests are published annually in Mississippi Farm Research.

Seeding Dates and Rates: Plant as soon after April 1, as weather permits, but not in cold soil. Hill dropped – 16 to 22 pounds of delinted seed per acre. Drilled – 30 to 40 pounds of delinted seed per acre. Drilled for cross plowing – 60 pounds of delinted seed per acre. Seed should be of good viability.

Fertilization: Delta soils generally need only nitrogen for most profitable yields but deficiencies of phosphate and potash do occur occasionally. This is especially true for potash on sandy loam and silt loam soils of the Eastern Delta and Foothill Area. Therefore, soils should be tested for phosphate and potash needs. Also, sandy soils that are low in organic matter or that have been leveled should be tested for sulfur needs.

Time: Apply nitrogen in the spring at or prior to planting, except on sandy loam soils having very good to excessive internal drainage and on clayey soils w poor surface drainage. On such soils, s application of nitrogen should be ma one-half at or prior to planting and rest as a side dressing preferably mid-June. Split application of nitrogen clays with poor surface drainage recommended because of possible loss nitrogen by denitrification during periods.

Rate: On sandy loam, loam, and loam soils rates from 90 to 100 pounds nitrogen per acre are recommended solid planted cotton and for all skipr patterns. One hundred to 120 pounds nitrogen per acre is recommended for silty clay loam, silty clay, and cl regardless of the planting pattern, exc that for clays with poor surface drain the rate should be 120 to 150 pounds nitrogen per acre.

For cotton following soybeans pasture sod, the nitrogen rate should exceed 60 pounds per acre, especia following pasture sod.

On soils where stalk growth is too ra maturity too late, and boll rot is problem because of excess nitrogen, nitrogen rate should not exceed pounds per acre.

All nitrogen fertilizer recommendati are on the basis of a planted a regardless of the planting pattern, that whether skiprow or solid.

Method: Same as for corn in the De Area.

COTTON IN HILL AREAS

Varieties: Results of variety tests a published annually in Mississippi Far Research.

Seeding Dates and Rates: Plant betwe April 10 and May 10 as weather permi Hill dropped – use 16 to 22 pounds well delinted seed or 12 to 16 pounds acid delinted seed per acre. Drilled – u 20 to 30 pounds of well delinted seed 15-20 pounds of acid delinted seed p acre. All seed planted should be of go quality.

Fertilization: A complete fertilizer (NK) containing sulfur and boron is ...ded in the Hill Sections. Fertilizers for ...h dark upland soils of the Northeast ...ckland Area having a pH above 6.0 ...uld contain enough water-soluble ...nesium to supply at least one-half and ...erably as much magnesia (MgO) as ...sh. On soils more acid than pH 6.0 ...nesium deficiency may be corrected ...applying dolomitic lime at the rate of ... to two tons per acre, or as indicated ...a soil test.

...nough boron is provided when the ...ed fertilizer contains boron and ...sphate in the proportion of 0.3 ...nds to 48, respectively, or a boron to ...sphate ratio of 1:160. No more than ... pounds of water-soluble boron should ...drilled with the fertilizer.

...cid soils should be limed according to ...l tests to maintain the pH above 5.5.

Time: Apply the phosphate and potash ...d all or part of the nitrogen at or a few ...eks before planting time. On deep ...dy or sandy loam soils with very good ... excessive internal drainage, side-dress ...e-half to two-thirds of the nitrogen for ...st effective results. Make side-dress ...plications of nitrogen by mid-June (a ...ek or more earlier if anhydrous ...monia is used), or at early square ...rmation.

Phosphate and potash may be applied ... the fall under certain conditions – see ...ction on When to Fertilize.

Rate: Apply 72 pounds of nitrogen (N) ...d 48 pounds each phosphate (P_2O_5) ...d potash (K_2O) per acre except as ...llows: Increase the nitrogen to 120 ...unds and the phosphate and potash to ... pounds each per acre on the dark ...land soils of the Blackland Areas, and ...crease the nitrogen to 90 pounds per ...re on the well-drained bottom and on ...e level to gently sloping upland soils of ...e Upper Coastal Plain. Excessive stalk ...owth and delayed maturity indicate too ...uch nitrogen. Somewhat stunted growth associated with yellowish green foliage and the early yellowing and premature shedding of the leaves indicate too little nitrogen. When these conditions are observed nitrogen rates should be adjusted accordingly.

Where a skip row planting pattern is followed the rate of nitrogen per planted acre should be the same as is recommended for solid cotton but the rate of phosphate and potash should be increased to 60 pounds of each per acre where a lower rate is recommended for solid cotton. In a 4 x 4 or 2 x 2 planting pattern there is, of course, only one-half acre of planted cotton.

Method: Same as for corn in Hill and Delta Foot Hill Areas. Contact placement of seed and fertilizer as well as placement directly beneath the seed should be avoided.

If the phosphate and potash are applied broadcast, the rate should be increased to 72 pounds of each per acre on soils known to be somewhat low in these nutrients. A soil test will indicate such conditions. However, as pointed out elsewhere, a higher rate generally will not be required on land previously cropped to cotton and fertilized as recommended. If a preemergence herbicide is to be broadcast and worked into the soil, phosphate and potash applied broadcast should be plowed down before the herbicide is applied.

SOYBEANS

Varieties: Delta Area – Hill, Dare, Davis, Lee, Semmes, and Bragg (listed in order of maturity).

Hill Section: North – Hill, Dare, Hood, Lee and Bragg. South – Dare, Bragg and Hampton 266; Hardee in extreme south.

For all areas where soils are infested with cyst nematode use either the Pickett or Dyer variety.

Soils: Soybeans are adapted to all Delta soils and to most soils of the Hill area,

but lower yields may be expected on droughty soils such as eroded and shallow upland soils.

Seeding Dates and Rates: May 1 to June 15 except extreme South Mississippi May 20 to June 20. Plant 40-50 pounds of good seed per acre.

Inoculation: If not on land where a crop of well nodulated soybeans has grown within the last five years, the seed should be inoculated.

Fertilization – Delta Area: Soybeans require no fertilizer on most Delta soils but a high percentage need lime. A soil test will indicate the need for lime as well as phosphate and potash.

In the Eastern Delta and Foothills Area a molybdenum seed treatment is needed for top yields on all soils that were previously acid regardless of current lime status, and elsewhere in the Delta on soils having a pH below 6.0. A seed treatment of 1/2 oz. of sodium molybdate per acre, or its equivalent is recommended.

Fertilization – Hill Area: In the Hill Area, phosphate and potash as well as lime usually are needed. Except for the dark soils of the Blackland Area of Northeast Mississippi, some 70 percent of the soils of the Hill Area need lime for top yield. In the absence of a soil test, apply both phosphate (P_2O_5) and potash (K_2O) in a 0-1-1 ratio at the rate of 40 to 50 pounds per acre. The fertilizer may be banded or broadcast. If broadcast, it should be plowed-in instead of disked-in for best results. If banded the fertilizer should be placed 3 to 4 inches below the seed. Avoid contact placement with the seed as well as band placement directly beneath the seed. Much newly cleared land, as well as land in unfertilized pastures, is extremely deficient in phosphorus and the rates indicated above probably will not be adequate for most profitable yields if this land is planted to soybeans. On such land the phosphate should be increased to 80 pounds per acre for a few years by using a mixed fertilizer of 0-4-3 ratio.

In some parts of the state dou cropping of small grain and soybeans m be practiced. In such a system it would satisfactory to apply all of the phosph and potash recommended for both cr to the small grain but they should broadcast and worked into the soil.

In the Hill areas a seed treatment ½ oz. of sodium molybdate per acre, its equivalent, is recommended on all s and especially on soils having a pH bel 6.0.

Because of injury to the bacter culture, the inoculant and sodi molybdate or other soluble molybdate other soluble molybdenum salts, shou not be premixed for more than 24 ho before being applied to seed beans th are planted immediately followi treatment. Actually, the best practice to apply the inoculation and molybda salt separately and then mix both wi the beans in the same operation.

RICE IN THE DELTA

Varieties: Long Grain: Bluebonnet Starbonnet, Dawn, and Bluebelle whi mature in 150, 142, 130 and 115 da respectively. Medium Grain, Saturn, Na and Nova 66 which mature in 125-1 days.

Seeding Dates and Rates: Rice can seeded from mid-April to mid-Ju depending upon variety. The very ear varieties should not be planted until Jun Seeding rate 90 to 110 pounds if drill and 110 to 135 pounds if broadcast water seeded.

Fertilization: Apply from 100 to 1 pounds of nitrogen per acre on old cr land. New land will probably require n nitrogen for the first one or two year The ammonium forms of nitrogen such ammonium sulfate and urea a recommended. Fertilizer may be appli before seeding if covered b approximately 2 inches of soi Otherwise, it may be applied just befo the first flood or one-half before the fir

...od and one-half at the correct "joint ...e." This stage occurs when the first ...n node or distance between the lowest ...y joints is ¾ inch for very early ...eties, ½ inch for Starbonnet and 1½ ...hes for other varieties. If all the ...rogen is applied before the first flood, ...not drain the field but maintain a ...tinuous flood for the entire season. ...ould all the nitrogen be applied in the ...od water the rates should be increased ...percent.

SORGHUMS FOR GRAIN, SILAGE

Varieties for Grains: AKS614, AKS663, Excel-Bird Go, DeKalb BR64, Funk G79, McNair 546, Savannah.

The above varieties may also be used for silage, especially when grown for high producing milk cows. However, bird resistant varieties may cause palatability problems in silage. Non-bird resistant varieties such as Funks G 522, DeKalb E7 and RS610 may be damaged by birds, but are much more desirable for a high quality silage.

Higher yielding sorghum for silage but giving somewhat lower quality are listed below:

Varieties for Silage: FSIA, NK300, Lindsey 101F.

Seeding Dates and Rates: April 20 to July 15. Earlier dates are preferred. If first harvest is made by July 25, a second cutting can usually be made if soil moisture is adequate.

Rates for Grain – Seed 6 to 9 lbs. of seed per acre in rows; for silage use 4 to 5 lbs. per acre in rows.

Fertilization: For comparable yields the soil fertility and fertilizer requirements of grain sorghum and corn are quite similar. However, grain sorghum usually does not yield as well as corn under conditions most favorable to production of both. Consequently, the average fertilizer requirement is not as high as for corn.

For Grain: In the Delta Area only nitrogen is needed generally. Depending upon the average yield, apply 100 to 180 pounds of N per acre, the lower rate for average yields of 60 to 70 bushels per acre and the higher rate for average yields of 100 to 120 bushels per acre. For intermediate yields, intermediate rates of nitrogen are recommended.

In the Hill Areas phosphate and potash as well as nitrogen generally are required. For average yields of 50 to 60 bushels per acre, apply 80 to 100 pounds of nitrogen (N) and 30 to 40 pounds each of phosphate (P_2O_5) and potash (K_2O) per acre. For average yields of 90 to 100 bushels per acre 140 to 160 pounds of N and 50 to 60 pounds each of P_2O_5 and K_2O.

Where a stubble crop is desired, apply an additional 40 to 60 pounds of nitrogen after the first crop.

Depending on soil productivity, average yields can be expected to range from 50 to 90 bushels per acre for early plantings where proper cultural and fertilization practices are followed. However, average yields above 80 bushels per acre can reasonably be expected only on the most highly productive soils, which would also be expected to yield 80 to 100 bushels of corn per acre. Average yields from late plantings (past July 1) would be considerably lower.

For Silage: Apply as for grain, except double the rate of potash.

Method of Application: Same as for corn.

SUGARCANE FOR SYRUP

Varieties: C. P. 36-111. On deep, well drained soils of light texture.

Seeding Dates and Rates: Cut seed cane at the top mature joint and at ground level, but do not strip before planting. Plant in the Fall (October 15) at the rate

of 2 stalks, that is, place stalks end to end with a whole stalk at the union. Plant the cane in 4-foot rows on land that has been broken 5 to 6 inches deep a few weeks earlier. To protect from cold and to provide good drainage, cover the cane 6 to 8 inches deep by forming a ridge over it so that the drainage furrows between the rows are 2 to 4 inches deeper than the cane.

Fertilization: In the spring apply 40 to 50 pounds each of nitrogen and phosphate (P_2O_5) and potash (K_2O) per acre shortly after germination of the eyes or just before re-growth from stub. Place the fertilizer in a band so that it will be 4 to 6 inches to the side of the r and 3 to 5 inches deep after the rid have been worked down, or 1 to 2 inc deeper than the cane. Sidedress w about 30 pounds of nitrogen per a before July. Place side-dressing nitro in the edge of the root zone deep enou to be in moist soil without be disturbed by subsequent cultivation.

Strip, top, and cut the cane bef freezing weather. Harvesting as much a month before processing improves su quality and reduces "sugaring."

GRASSES, LEGUMES, AND SMALL GRAINS

Supplementary Information on Pasture Recommendations for the Hill Section

Planting:

If equipment is available, drill or band placement of seed and fertilizer is recommended for the establishment of all pasture and forage crops. With small-seeded legumes and grasses, care must be taken not to seed too deep. A seeding depth no more than ½-inch is recommended. Most plantings are made by broadcasting the seeds on the soil surface. In which case the seedbed should be cultipacked immediately before or after seeding.

Clover Pastures and Bloat:

Where conditions are especially favorable for legumes the danger of bloat may prevent full utilization of legumes seeded alone or of grass-legume combinations such as Dallis-grass and white clover, particularly in the Deep Loess area. The drilling of small grains or ryegrass into such a pasture will lessen the bloat problem and supply additional forage. In North Mississippi, orchardgrass may be seeded to reduce bloat in clover pastures.

Fertilization: For established pastures, solid and liquid complete fertilizers and solid sources of nitrogen may be top-dressed. On summer grass pastur however, the efficiency of top-dress urea-ammonium nitrate (non-pressu solutions has been quite low compared solid ammonium nitrate.

Because of the wide variety of soils which these pasture recommendatio will be applied, and of the extensi nature of the typical commerci livestock operation in Mississipp particularly beef cattle, the pastu fertilizer recommendations are general presented as a range instead of a sing and more arbitrary figure.

The lower limit of t recommendation is estimated to b sufficient for plant establishment and (for reasonable yields of forage on soi well adapted to the particular pastu crop under consideration, (2) for perio of economic stress during which it is st necessary to maintain a reasonable suppl of cheap forage, and (3) where acreag per animal unit is not a serious limitin factor.

The upper limit of the fertiliz recommendations continues to be th agronomic optimum and should be use where the (1) soil type, (2 management system, (3) type of livestoc enterprise, and (4) economic trend ar such as to justify the considerably high

's of forage that result from its use.

r winter growing grass-legume inations, the amount of nitrogen and the time of application depend arily upon when grazing is needed upon the desired proportion of grass legume. Although there is very little ference in the total season's uction of forage, fall applications plant establishment, increase fall and er yields, and tend to provide a more able grass-legume ratio. For milking s, lambs and other classes of livestock stem of managements where fall and er grazing is important, and where ger of bloat exists, application of 0 lbs. N at planting time is mmended.

e yield of grass forages is greatly eased by application of nitrogen and, re weather conditions do not limit th, excellent response is obtained to rates of nitrogen; therefore, the most nomical rate will depend upon perature, availability of moisture, and use made of the additional forage.

increase the utilization of the ogen or to obtain a more favorable ribution of pasture production, split plications of nitrogen are mmended for both summer and ter grass pastures, with 60-120 pounds g applied each time.

or winter growing grass or grass-me pastures that are seeded late and n which no fall or winter grazing can expected the nitrogen application uld not exceed 30 lbs. at seeding per .

xcept for coastal bermudagrass, where last application may be as late as ust 15, the last application of ogen to permanent summer pastures uld be made no later than July 15, and two weeks earlier if anhydrous ammonia is used. Because of the frequency of drought, mid-summer applications of nitrogen are generally less effective than applications made in the spring and early summer. For this reason more nitrogen should be applied in the spring than in summer season.

It may be economical to apply up to 200 pounds of nitrogen per acre to millet and sudangrass; 200 pounds to common Bermudagrass, Dallisgrass, and Bahiagrass, and 240 pounds to Coastal Bermudagrass pasture.

For summer temporary grazing crops, best response is obtained from nitrogen incorporated into the seedbed with phosphorus and potash prior to planting. Surface applications after each grazing or cutting are effective if rainfall is adequate.

Fall application of phosphorus or potash to pastures is recommended if these nutrients are necessary to establish forage seedlings in the fall. However, spring application is slightly more effective for spring and summer growth of perennial plants and those which come up in the spring. In general, fertilizers should be applied as close as practical to the time they are to be used by plants, therefore seasonal, annual applications are indicated in the following tables on forage and pasture crops. If phosphate and potash are applied only once in two years to permanent pastures the rate per application should be twice the annual rate.

Inoculation of clovers: All seed of clovers and other forage legumes should be inoculated with the proper culture prior to planting. It is imperative that seeds of new clovers like Arrowleaf be inoculated just prior to planting. Failure to inoculate legumes will result in low yields and may cause stand failure.

RECOMMENDATIONS FOR DELTA PASTURE AND SMALL GRAIN CROPS

Pasture Crop	Recommended Varieties	Rate of Seeding Per acre	Time of Planting	Fertilization, lbs./A. Annual Application, Except Lime.
Alfalfa	Delta, Buffalo or Cody	15-20 lbs.	Sept. 1-Oct. 15	Test soil for lime, Phosphorus, and potash needs.
Bermudagrass	Coastal (Irrigated)	20 bu. sprigs	Nov. 1-May 1	180 lbs. N, 2-3 applications beginning June 1 for grazing I or hay, 300 lbs. N.
Bermudagrass White Clover	Regal, Tillman, or La. S-1,	2 lbs.	Plant Clover Sept. 1-Oct. 15	Test soil for lime, phosphorus, and potash needs.
Fescue and White Clover	Kentucky-31 Fescue, Regal or La. S-1 White Clover	10 lbs. Fescue 1-2 lbs. Clover	Oct. 1-Nov. 1 Feb. 1-May 1	Test soil for lime, phosphate, and potash needs.[1]
Red Clover	Orbit or Kenland	10-15 lbs. seed alone or in small grains	Oct. 1-Nov. 1	Test soil for lime, phosphate and potash.
White Clover	Tillman, Regal, La. S-1, or Merit	2-3 lbs.	Oct. 1-Nov. 1	Test soil for lime, phosphate and potash
Arrowleaf Clover	Meechee or Yuchi	12-15 lbs.	Oct. 1-Nov. 1	Test soil for lime, phosphate and potash.
Sorghum-Sudan hybrids	Commercial varieties	20 lbs. in rows 35 lbs. broadcast	Apr. 15-June 15	60 lbs. N prior to planting. 60 lbs. N after 1st and 2nd cutting.
Korean Lespedeza	Climax or Summit	20-25 lbs. seed in small grains	Feb. 15-Mar. 15	Test soil for lime, phosphate, and potash.
Oats	Coker 242, Nora, or Florida 501	3 bu. for grazing 2½ bu. for grain	For grazing, early Sept. For grain mid-Oct.	Grazing: 60 lbs. N at planting and 60 lbs. in Feb. Grain: 45 to 60 lbs. N March 1-March 15
Wheat	Benhur, Bledsoe, Blueboy, Coker 65-20, or Wakeland	1¼ bu. for grain 1½ bu for grazing	Same as Oats	Same as Oats.
Rye	Explorer or Elbon	1¼ bu. for grain	Same as Oats	Same as Oats.

Pasture Crop	Recommended Varieties	Time and Planting	Rate of seeding Per Acre	Fertilization, lbs./A Annual Fertilization[1]
WARM SEASON GRASSES (PERMANENT)				
Bahiagrass	Pensacola, Wilmington, (Argentine South Mississippi only)	Feb.-April, or Aug.-Oct.	15 lbs./A	120 to 180 lbs. N in split applications and 30 to 45 lbs. each of P_2O_5 and K_2O. Total application in a 4-1-1 ratio.
Bermudagrass	Common	Feb.-May	3-5 lbs. seed	Same as for Bahiagrass.
	Coastal	Feb.-May	20 bu. of sprigs per acre	**For Grazing:** 120 to 240 lbs. N in split applications and 30 to 60 lbs. each of P_2O_5 and K_2O. Total application in 4-1-1 ratio. **For Hay:** 200 to 300 lbs. N in split application; 50 to 90 lbs. of P_2O_5; 100 to 180 lbs. K_2O. Total application in a 4-1-2 ratio.
Dallisgrass	Commercial	Feb.-April; Aug.-Oct.	10 lbs. (live seed)	Same as Bahiagrass.
Johnsongrass	Commercial	Feb.-June	15-25 lbs. (live seed)	Same as for Coastal Bermudagrass.
COOL SEASON GRASSES (PERMANENT)				
Tall Fescue	Kentucky-31 or Kenwell.	Aug.-Oct. 15	15 lbs.	80 to 140 lbs. N, split fall and spring; 40 to 60 lbs. each of P_2O_5 and K_2O in a 1:1 ratio.
Orchardgrass (North Miss. only)	Jackson or Boone	Aug.-Oct. 15	15 lbs.	Same as Tall Fescue

Recommendations For Pastures In Hill Sections–(Continued)

Pasture Crop	Recommended varieties	Time of Planting	Seeding Per Acre	Fertilization, lbs./A. Annual Application[1]
WARM SEASON GRASS-LEGUME MIXTURES (PERMANENT)				
Bahiagrass, Bermudagrass Dallisgrass with one of the following legumes.		As before	As before	**Establishment:** 60 to 100 lbs. of P_2O_5 and 30 to 50 lbs. K_2O in a 2:1 ratio.
White Clover	Regal, Tillman or Merit	Sept. 1-Oct. 15	1-3 lbs.	**Maintenance:** 30 to 60 lbs. of P_2O_5 and K_2O in a 1:1 ratio.
Crimson Clover	Chief, Autauga or Tibbee	Sept. 1-Oct. 15	25 lbs.	Same as above, For seed production add 0.5 to 1 lb. of boron.
Arrowleaf[1]	Meechee or Yuchi	Sept. 1-Oct. 15	10-15 lbs.	Same as Crimson Clover.
Lespedeza	Climax, or Summit	Feb.-April	20 lbs.	**Establishment:** 40-60 lbs. each of P_2O_5 and K_2O in a 1:1 ratio. **Maintenance:** 40 lbs. each of P_2O_5 and K_2O.
Johnsongrass with one of the following for hay:	Commercial	Feb.-June	15-25 lbs. (live seed)	
Alfalfa	Florida 66, Delta, Cody, or Buffalo	Sept.-Oct.	15 lbs.	**Establishment:** 120 to 160 lbs. each of P_2O_5 and K_2O in a 1:1 ratio. **Maintenance:** 60 to 80 lbs. P_2O_5 and 180 to 240 lbs. K_2O in a 1:3 ratio plus boron.
Red Clover	Orbit, Kenland or Chesapeake	Sept.-Oct. or or March 1-April 15 on clean land.	10 lbs.	Same as with Alfalfa.
Rough Peas	Commercial, also known as Caley, Singletary, and	Sept.-Oct.	30 lbs.	60 to 90 lbs. P_2O_5 and 120 to 180 lbs. K_2O in a 1:2

Millet	Gahi-1, Millex, or Pearlet	Apr. 15-June 15	10 lbs. in rows 25 lbs. broadcast	120 lbs. N, split application, 60 lbs. P_2O_5 and 60 lbs. K_2O
Sorghum-Sudan hybrids	Commercially available varieties	April 15-June 15	15 lbs. in rows 35 lbs. broadcast	120 to 180 lbs. N in split applications, 60 lbs. P_2O_5 and 60 lbs. K_2O

COOL SEASON GRASS-LEGUME MIXTURES (ANNUAL OR TEMPORARY)

Annual Ryegrass without, or the following	Gulf, Magnolia, Blends or (Common or North Miss. only)	Aug. 25-Oct. 15	25 lbs	0-60 lbs. N, 60-100 lbs. P_2O_5 and 30 to 50 lbs. K_2O in a 2-1 ratio at seeding time
Arrowleaf Clover[1]	Meechee or Yuchi	Aug. 25-Oct. 15	10 lbs	
Crimson Clover	Autauga, Chief, or Dixie	Aug. 25-Oct. 15	20 lbs	Same as above
Annual Ryegrass and wheat or oats with legume (as with ryegrass)	As above	Aug. 25-Oct. 15	20 lbs.	Same as above
	See wheat and oats	Aug. 25-Oct. 15	90 lbs	
Small Grains and Legume (Use same as with ryegrass)	Oats, rye or wheat (See varieties under grass)	Aug. 25-Oct. 15	90 lbs. of small grain	Same as above

COOL SEASON GRASS-LEGUME MIXTURES (PERMANENT)

Tall Fescue	Alta, Kentucky-31 or Kenwell	Aug. 20-Oct. 15	10 lbs. in 20 rows	**Establishment:** 60 to 100 lbs. of P_2O_5 and 30 to 50 lbs. of K_2O in a 2-1 ratio.
Orchardgrass (North Mississippi only)	Commercial, Boone or Jackson	Aug. 20-Oct. 15	10 lbs.	**Maintenance:** 40 to 60 lbs. of P_2O_5 and K_2O in a 1-1 ratio.
with				
White Clover	Regal, Tillman, or La. S-1	Aug. 20-Oct. 15	1-3 lbs	

[1] Specify scarified seed

Recommendations For Pastures In Hill Sections–(Continued)

Pasture Crop	Recommended varieties	Time of Planting	Seeding Per Acre	Fertilization, lbs./A. Annual Application[1]
		ANNUAL COOL SEASON GRASSES AND SMALL GRAINS		
Annual Ryegrass	Gulf, Magnolia, or Florida Rust Resistant. (Common in North Miss. only)	Aug. 20-Oct. 15	20-30 lbs.	120 to 220 lbs. of N, split fall and spring, 80 to 100 lbs. P_2O_5 and 40 to 50 lbs. K_2O in a 2-1 ratio.
Barley (Grain only)	Dayton, Harrison, Kenbar, or Decatur	Oct. 1-Nov. 15	1½ bu.	10-15 lbs. N, 20-30 lbs. each of P_2O_5 and K_2O, at seeding. Topdress with 40 to 60 lbs. N about March 1
Oats	Coker 242, Forager®, Moregrain 211 Nora, or Sumpter	For Forage Aug. 20-Oct. 1 For Grain Oct. 1-Nov. 15	For Forage 128 lbs. (4 bu.) For Grain 2½ bu.	Same as Ryegrass Same as Barley
Rye	Albon, Explorer or Abruzzi NC	For Forage: Same as Oats For grain Oct. 1-Nov. 1	For Forage 90 lbs For Grain 2½ Bu.	Same as Ryegrass Same as Barley
Wheat	Arthur, Blueboy, Coker 65-20 Georgia 1123 Andrus, Wakeland, or Coker 68-15	Same as for Rye	For Forage 90 lbs For Grain 1½ bu.	Same as Ryegrass. Same as for Barley

[1] For Forage only.

Alfalfa (Hay)	Florida 66, Delta, Cody, or Buffalo	Aug. 15-Oct. 15	15-25 lbs.	**Establishment:** 120 lbs. each of P_2O_5 and K_2O in a 1:1 ratio and 1.5 lbs. boron. **Maintenance:** 60-80 lbs. P_2O_5 and 180 to 240 lbs. K_2O in a 1:3 ratio and add 1 lb. boron
Arrowleaf Clover[2]	Meechee or Yuchi	Sept.-Oct. 15	10 lbs.	60 lbs. each of P_2O_5 and K_2O in a 1:1 ratio. For seed production add 0.5 to 1.0 lb boron.
Austrian Winter Peas	Commercial	Sept.-Oct. 15	50 lbs.	Same as for Arrowleaf Clover.
Crimson Clover	Autauga, Chief, or Frontier	Sept.-Oct. 15	20-30 lbs.	Same as for Arrowleaf Clover.
Lespedeza (Annual) Sericea (Perennial)	Climax, or Summit Serala, or Commercial	Feb.-April 15 Feb.-June	25 lbs 30-40 lbs	Same as for Arrowleaf Clover.
Red Clover (Hay)	Orbit, Kenland or Chesapeake	Sept. 1-Aug. 15 Mar.-Apr. 15	10 lbs.	**Establishment:** 60 to 100 lbs each of P_2O_5 and K_2O in a 1:1 ratio **Maintenance:** 50 lbs. P_2O_5 and 100 lbs. K_2O in a 1:2 ratio
Rough Pea	Commercial - also known as Singletary, Caley and Wild Winter peas	Sept. 1-Oct. 15	40 lbs.	Same as for Arrowleaf Clover.
Vetch	Warrior	Sept. 1-Oct. 15	30 lbs.	Same as for Arrowleaf Clover.
White Clover	Regal or Merit	Sept. 1-Oct. 15	2-3 lbs.	Same as for Arrowleaf Clover.

[1]For legumes and grass-legume combinations, soil should be limed initially to establish and subsequently to maintain a pH of 6.0 to 7.0, for non-legumes the pH range should be 5.5 to 6.5. Refer to section on Soil pH and Liming. Unless indicated otherwise fertilizer recommendations are for grazing. When forage and pasture crops are harvested repeatedly from the same area for hay or silage instead of being grazed, the rate of potash should be about twice that recommended for grazing.

[2]Specify scarified seed.

RECOMMENDATIONS FOR LAWNS AND SIMILAR TURF AREAS

Grass	Recommended Varieties	Method of Planting	Rate of Planting	Fertilization per 1000 sq. ft. per Yr.[1]
Bahiagrass	Pensacola or Wilmington	Seed	5-10 lbs./1000 sq. ft	6 lbs. nitrogen 2 lbs. P_2O_5 4 lbs. K_2O split into 4 applications
Bermudagrass	Common	Seed	2 lbs./1000 sq. ft.	6-8 lbs. nitrogen 2 lbs. P_2O_5 3-4 lbs. K_2O, split into 4 applications
	Tiflawn, Ormond, Tifway, Tifdwarf, or	Sprig or plug	Sprig or plug 6-12 ins. apart on 6-12 in. rows	
	Tex-turf 10	Stolonize	2-5 bu./1000 sq. ft	
Carpetgrass	Common	Seed	5 lb./1000 sq. ft	2-3 lbs. nitrogen 1 lb. P_2O_5 1-2 lbs. K_2O, split into 2-3 applications
Centipedegrass	Common or Oklawn	Seed Sprig or plug	4 oz./1000 sq. ft. Sprig or plug 6-12 ins. apart on 6-12 in. rows	Same as carpet
Fescue	K-31, or Kenwell	Seed	7-10 lbs./1000 sq. ft	4 lbs. nitrogen (2 in fall, 2 in spring) 2 lbs. P_2O_5 and 4 lbs. K_2O
Ryegrass	Gulf, or Magnolia	Overseed permanent lawns	8-10 lb./1000 sq. ft	1 lb. nitrogen in January if needed
St. Augustinegrass	Common	Sprig or plug	Sprig or plug 6-12 ins. apart on 6-12 in. rows	Same as bahia
Zoysiagrass	Emerald, Matrella, or Meyer	Sprig or plug	Sprig or plug 6 ins. apart on 6 in. rows	Same as bahia

[1] When establishing a new lawn incorporate 2-3 lbs. of N, 4-6 lbs. of P_2O_5 and 2-3 lbs. of K_2O per 1000 sq. ft. into the seedbed prior to planting.

Cost Reduction Research For Cotton Production Systems In The Yazoo-Mississippi Delta

By W. I. SPURGEON

and FRED T. COOKE, JR.

JAN 21 1971

MISSISSIPPI STATE UNIVERSITY

AGRICULTURAL AND FORESTRY EXPERIMENT STATION

JAMES H. ANDERSON, Director

ATE COLLEGE MISSISSIPPI

OST REDUCTION RESEARCH FOR COTTON PRODUCTION SYSTEM IN THE YAZOO-MISSISSIPPI DELTA (A PROGRESS REPORT)

By W. I. SPURGEON[1] and FRED T. COOKE, JR.[2]

/ith the increasing costs of production ruts and declining prices for cotton, ys to reduce the cost of growing ton must be found. This study is igned to look at some practices which ght reduce production costs in cotton.

Experiments have been carried out each ir since 1966 at the Delta Branch periment Station, Stoneville, ssissippi, to study the effect of seedbed paration and preemergence herbicides cotton yield and cost of production. e experiments consisted of 12 different dbed preparation and preemergence bicide treatments over the 4-year iod (table 1).

Field plots were 4 to 8 rows in width tended the length of the field. Two to ir fields were used each year with row gths ranging from 440 to 1,080 feet. A ndomized block design was used with 2 7 replications according to field size. A x 4 skip-row pattern was planted the st two years and a solid pattern the last o years. These experiments were nducted on various soil types which cluded Bosket very fine sandy loam, ndee silty clay loam, and Tunica silty ay.

Stalks were cut and all plots sub-soiled rpendicular to the row direction in the ll. Spring seedbed preparation of the dded and flat planted plots consisted of o chiselings, two diskings, and one noothing operation with a ringtoothed harrow or "Do All"[3]. here a preplant herbicide such as reflan or Planavin was used, it was corporated with the "Do All." The dded plots required an additional peration with a middle buster or row pper and in some cases, depending on eather and weed growth, it was necessary to use the hippers a second time. The stubble planted plots required, in addition to the application of contact herbicide, one operation with a "Do All" to smooth and fill the crevices left by the fall subsoiling.

All fields and treatments each year were planted with the Stoneville 213 variety using a sword opener planter in conjunction with front mounted Stoneville blades. The banded herbicides, systemic insecticides, and soil fungicides were applied during the planting operation. A double disk opener planter might have performed better on the flat and stubble planted plots, but it was unavailable.

Postemergence weed control including cultivation, herbicides, and flame were used as needed. Four rows of all plots were harvested with a 2-row mechanical picker twice each year except in 1968 when only one harvest was required.

Weed Control

Weed control was more difficult where cotton was planted flat as compared to that planted on beds. Treflan or Planavin broadcast and incorporated was more

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[3] Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the Experiment Station and does not imply its approval to the exclusion of other products that may also be suitable.

effective on the flat planting than any of the 20-inch band treatments, Karmex broadcast on the surface and/or Karmex broadcast and incorporated. The banded treatments of Karmex and Cotoran were equal to incorporated Treflan and Planavin so far as postemergence weed control was concerned. The most effective treatment for control of most weed species involved in these tests was Treflan and Planavin broadcast and incorporated before planting plus a 20-inch band of Cotoran or Karmex at planting. However, this is an expensive method of control that might be accomplished more economically with less herbicides and more intensive cultivation.

Where Treflan or Planavin was used for 2 to 4 years, annual grass control was excellent, but there was a definite increase in the population of prickly sida. The continued use of Karmex or Cotoran, as compared with Treflan or Planavin, increased the incidence of annual grasses but was better for control of prickly sida. Alternating the use of Treflan or Planavin and Karmex or Cotoran where both annual grasses and prickly sida are problems might be a more practical solution to preemergence weed control.

Plant Growth and Yield

Adequate yield surface drainage is a prerequisite to flat planting. It was difficult to obtain stands where surface drainage was inadequate, especially where frequent and heavy rains occurred immediately after planting flat. The greatest drainage problems encountered with the flat planting in these tests were in the 4 x 4 skip-row pattern where the seedbed was prepared on four rows and left unprepared on the other four. After planting, the 4-row skips acted as lateral dams and caused some flooding during heavy rainfall. This problem also occurred to a lesser extent on the 8-row plots of solid planted cotton, especially where the flat plot was bordered by bedded plots. This would be of no consequence in a farm sized field where the land was uniformly prepared, especially on l formed fields.

The flat and stubble planting was m efficiently accomplished in the silty loam and silty clay than in the very sandy loam soil. Less soil compac after seedbed preparation on the hea soil types could account to some ex for improved planting efficiency.

The stubble planted cotton emer and grew faster than flat or conventi bed planted cotton. Compaction crusting of the soil surface was redu by plant residue which probably ai emergence.

As indicated in Table 1, there was significant difference in cotton y between any of the treatments for year. In 1966, weed control inadequate for treatments 3, 8, an where herbicides were banded. The lo yields of these three treatments w probably caused by weed competiti The 20-inch banded herbicide treatme on the flat plots were very inefficient were abandoned after 1966.

There were significant differences yield between some treatments on cert soil types and in certain years as show Table 2. In 1967, yields were significa reduced in field 9 (Bosket very fine sa loam soil) where Treflan was broadc and incorporated preplant and Coto applied in a 20-inch band at planti Late maturing cotton combined wit November 3 freeze (approximat normal) was probably responsible for l yields.

The second-year stubble planted cot in field 2 produced significantly m cotton in 1968 than any of the othe treatments. There is no adequ explanation for this yield increase fr 2-year stubble planting except that cotton plants emerged sooner, gr faster, and matured earlier.

The stubble planted cotton produc significantly less cotton than any oth treatment in field 9 in 1968. The lov yield from stubble planting in this c was probably caused by inadequate pla stands. Field 9 was heavily infested w

ennial rescuegrass which made stubble ting difficult with a sword opener ter. However, rescuegrass is not a blem weed on Delta farms. This field infested as a result of earlier cuegrass experiments.

1969, yields from 3 years of stubble nted cotton in field 2 were nificantly higher than the other six atments. The 3-year stubble planting in d 7, while not significant at the 0.05 el, produced considerably more cotton n all other treatments. There seems to some benefit derived from continuous bble planting because in 1969 3-year bble produced more than 1-year bble cotton.

able 3 shows the average of all flat and ded treatments of all fields for a ear period compared with the average ld of stubble planted cotton. There s practically no difference in yield tween the three seedbed preparation thods in 1967. Yield was slightly her from two consecutive years of bble planted cotton in 1968 as mpared with bedded and flat planted atments. The yield advantage was even ater in 1969 after three consecutive ars of stubble planting. The 3-year erage shows a definite yield increase m stubble planting.

The greatest disadvantage of stubble anting in this study was the high cost of e contact herbicides used to destroy nter vegetation. It may not be cessary to destroy winter vegetation cause most of these weeds mature and e shortly after cotton is planted. xperiments are now in progress to termine if winter weeds should be stroyed and to develop cheaper ethods for destroying them.

Stubble planting is not presently commended by the Mississippi gricultural and Forestry Experiment ation, however, if farmers should tempt to plant in this manner it is ggested that they plant a small acreage a relatively weed-free field. It should ot be planted in a field infested with erennial weeds or verticillium wilt.

Costs Associated with Various Seedbed Preparation and Weed Control Methods

Records were kept on each operation associated with seedbed preparation and weed control. Tractor costs are those associated with an 80 horsepower tractor, labor costs were assumed to be $1.50 per hour, and the materials were priced as of January 1970. Interest on operating capital was charged at 8 percent for 6 months. Tables 4, 5, and 6 present the seedbed preparation costs associated with conventional seedbed preparation, flat seedbed preparation, and stubble seedbed preparation, respectively. Fertilization and planting are included to make all seedbed preparation methods compatible. From these tables it can be seen that stubble seedbed preparation is $3.39 cheaper per acre than conventional seedbed preparation and $1.62 cheaper than flat seedbed preparation. Because the stubble cotton was sidedressed, a lower rate of nitrogen fertilizer was used, costing $1.71 less. The cost of sidedressing of $1.28 partially offset the lower fertilizer cost. After adjusting for fertilizer costs, stubble seedbed preparation is $2.96 cheaper than conventional seedbed preparation, and $1.19 cheaper than flat seedbed preparation. The cost of the contact herbicide used, Paraquat and MSMA, offset much of the savings resulting from the reduced number of operations. If one bedding (hipping) could be substituted for these chemicals, an additional savings of $4.14 could be made with stubble planting. That is, the cost of the chemicals ($4.13) and application ($1.08), less the cost of bedding ($1.07).

This analysis does not include any consideration of yield increase associated with continuous stubble seedbed preparation, but if such a response can be proven the extra yield will have to be considered in any future analysis of stubble seedbed preparation.

The effects of various preemergence herbicides and combination of pereemergence herbicides on total weed

Table 1. Cotton yields of systems tests, Delta Branch Experiment Station, Stoneville, Mississippi (1966-1969).

Treatments	Plant 4 - skip 4			Solid planted		
	1966 4 fields	1967 3 fields	66-67 Avg.	1968 2 fields	1969 3 fields	68-69 Avg.
	Pounds of seed cotton per acre					
1. Bed, plant, Farmex 20" band	4053	3846	3950	2392	2132	2262
2. Bed, plant, Cotoran 20" band	--	--	--	--	2206	--
3. Bed, Treflan 20" band, plant	3789	--	--	--	2174	--
4. Treflan broadcast, bed, plant	3876	3799	3838	2338	2288	2313
5. Treflan broadcast, bed, plant Farmex 20" band	--	--	--	2403	2123	2263
6. Treflan broadcast, bed, plant Cotoran 20" band	--	3599	--	2371	--	--
7. Treflan broadcast, plant flat	4044	3673	3859	2411	2097	2254
8. Treflan 20" band, plant flat	3789	--	--	--	--	--
9. Plant flat, Farmex 20" band	3638	--	--	--	--	--
10. Plant flat, Farmex broadcast on soil surface	--	3772	--	--	--	--
11. Farmex broadcast and incorporated, plant flat	--	--	--	2474	--	--
12. One pint each Paraquat and MSMA broadcast on vegetation, stubble plant, Cotoran 20" band	--	3761	--	2546	2444	2495
LSD @ .05	NS	NS		NS	NS	

* Planavin was substituted for Treflan in 1968.

Table 2. Significant yield differences in the cotton systems tests, Delta Branch Experiment Station, Stoneville, Mississippi (1967-1969).

Treatments	1967	1968		1969	
	Field 9[1/]	Field 2[2/]	Field 9	Field 2	Field 7[3/]
	Pounds of seed cotton per acre				
1. Bed, plant, Karmex 20" band	3968	2252	2531	2021	2051
2. Bed, plant, Cotoran 20" band	--	--	--	2281	2089
3. Bed, Treflan 20" band, plant	--	--	--	2046	2033
4. Treflan broadcast, bed, plant	3853	2299	2377	2401	1995
5. Treflan broadcast, bed, plant, Karmex 20" band	--	2377	2428	2001	2089
6. Treflan broadcast, bed, plant, Cotoran 20" band	3517	2196	2546	--	--
7. Treflan broadcast, plant flat	3831	2184	2637	2162	1753
10. Plant flat, Karmex broadcast on soil surface	3963	--	--	--	--
11. Karmex broadcast and incorporated, plant flat	--	2372	2430	--	--
12. One pint each Paraquat and MSMA broadcast on vegetation, stubble plant, Cotoran 20" band	3909	2949	2143	2640	2387
LSD @ .05	236	425	190	239	N.S.
C.V.	6.2%	12.0%	6.6%	7.2%	

1/ Field 9 - Bosket very fine sandy loam soil 7 replications.
2/ Field 2 - Dundee silty clay loam soil 4 replications.
3/ Field 7 - Tunica silty clay soil 2 replications.

control costs were evaluated. As indicated in another portion of this report, there was some variation between tests in some fields in some years. Generally, however, the type of preemergence herbicide used did not affect inputs for postemergence weed control. Tables 7 through 11 indicate total costs associated with various preemergence herbicides. The cost of the preemergence herbicides plus their application determined the difference in total costs as all postemergence weed control practices and inputs are the same. The total costs ranged from $23.00 p acre where a 20-inch band of Karmex s used to $29.37 per acre broadcast Tref plus a 20-inch band of Cotoran.

Every preemergence herbicide r combination of preemergence herbici may have some usefulness in specific g and weed situations. It would app however, that weed control costs cotton can be reduced if the m appropriate preemergence herbicide w used for the grass and weed situatio each cotton field.

Summary

Experiments were conducted over a 4-year period (1966-1969) on different soil types at the Delta Branch Experiment Station, Stoneville, Mississippi, to study the effect of seedbed preparation and preemergence herbicides on cotton yield and cost of production.

1. In 1967, first-year stubble planted cotton yields were equal to those of cotton (conventional seedbed preparation) planted flat and on beds.

2. In 1968, second-year stubble planted cotton yields were higher than those of cotton planted flat and on beds.

3. The third-year stubble planting produced significantly more cotton in 1969 than the flat and bedded plantings.

4. The contact herbicides (Paraquat and MSMA) used to kill winter weeds in the stubble planted cotton were expensive ($4.13 per acre for herbicides). If winter weeds must be controlled, chea methods must be devised.

5. Incorporated Treflan or Plana gave better control of annual grasses the incidence of prickly sida increa where these herbicides were u continuously.

6. Banded Karmex and Cotoran. most cases, adequately controlled an grasses and gave better control of pric sida than Treflan and Planavin.

7. There was no difference in number or cost of postemerge operations required to control weeds any of the preemergence herbic treatments.

8. Total per acre cost includ preemergence herbicides, application, all subsequent postemergence operati ranged from $23.01 for a 20-inch banc Karmex to $29.37 for incorpora Treflan plus a 20-inch band of Coto

ble 3. Effect of seedbed preparation on yield of cotton, Delta Branch Experiment Station, Stoneville, Mississippi.

Treatment	Plant 4 - skip - 1967[1]	Solid planted 1968[2]	Solid planted 1969[2]	3-year average
	Pounds of seed cotton per acre			
onventional seedbed planted [illegible]	3748	2376	2185	2770
onventional seedbed planted flat	3723	2443	2097	2754
ubble planted[3]	3701	2546	2444	2917

/erage of 3 fields.
/erage of 2 fields.
/ ubble planted 1, 2, and 3, consecutive years for 1967, 1968, and 1969, spectively.

ble 4. SOLID COTTON: Estimated costs per acre, 4-row equipment, sandy soils, conventional seedbed preparation.

peration	Tractor costs Direct	Tractor costs Fixed	Equipment costs Direct	Equipment costs Fixed	Labor costs	Materials costs
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
u stalks	.37	.24	.05	.18	.36	--
soil	1.01	.64	.18	.27	.98	--
sel	.47	.29	.08	.17	.45	--
sel & Fertilize	.51	.32	.09	.19	.50	6.16
k	.36	.23	.17	.29	.35	--
k	.36	.23	.17	.29	.35	--
	.31	.20	.10	.16	.30	--
ed	.31	.20	.10	.16	.30	--
condition	.31	.20	.12	.24	.30	--
nt & preemerge	.37	.24	.21	.44	.72	5.41
ctor and trailer	.10	.12	.06	.13	.40	--
totals	4.48	2.91	1.33	2.52	5.01	11.57
Interest on operating capital			.90			
Total costs per acre			28.72			

le 5. SOLID COTTON: Estimated costs per acre, 4-row equipment, sandy soils, flat seedbed preparation.

ration	Tractor costs Direct	Tractor costs Fixed	Equipment costs Direct	Equipment costs Fixed	Labor costs	Materials costs
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
stalks	.37	.24	.05	.18	.36	--
soil	1.01	.64	.18	.27	.98	--
sel	.47	.29	.08	.17	.45	--
sel & fertilize	.51	.32	.09	.19	.50	6.16
k	.36	.23	.17	.29	.35	--
k	.36	.23	.17	.29	.35	--
condition & corporate herbicides	.31	.20	.12	.24	.30	2.94
nt	.37	.24	.21	.44	.72	2.88
ctor & trailer	.10	.12	.06	.13	.40	--
totals	3.66	2.51	1.13	2.20	4.41	11.98
Interest on operating capital			.86			
Total costs per acre			26.95			

Table 6. SOLID COTTON: Estimated costs per acre, 4-row equipment, sandy y
stubble seedbed preparation.

Operation	Tractor costs		Equipment costs		Labor	Mat
	Direct	Fixed	Direct	Fixed	costs	c
	Dollars	Dollars	Dollars	Dollars	Dollars	Do
Cut stalks	.37	.24	.05	.18	.36	
Subsoil	1.01	.64	.18	.27	.98	
Row condition	.31	.20	.12	.24	.30	
Apply contact herbicides	.39	.25	.03	.04	.37	
Sidedress	.39	.25	.03	.13	.38	
Plant	.37	.24	.21	.44	.72	
Tractor and trailer	.10	.12	.06	.13	.40	
Subtotals	2.94	1.94	.68	1.43	3.51	1
Interest on operating capital		.84				
Total costs per acre		25.33				

Table 7. SOLID COTTON: Weed control costs, 4-row equipment, sandy soils,
Karmex on 20-inch band.

Operation	Tractor costs		Equipment costs		Labor	Mate
	Direct	Fixed	Direct	Fixed	costs	co
	Dollars	Dollars	Dollars	Dollars	Dollars	Dol
Banded Karmex	--	--	.04	.09	--	1
Cultivate	.39	.25	.08	.14	.38	
Cultivate and postemerge	.43	.27	.11	.19	.42	1
Cultivate & postemerge	.43	.27	.11	.19	.42	1
Cultivate & postemerge	.37	.24	.09	.17	.36	
Cultivate & flame	.45	.28	.11	.20	.44	
Cultivate & postemerge	.37	.24	.09	.17	.36	2
Hand weed control	--	--	--	--	6.00	
Subtotals	2.44	1.55	.63	1.15	8.38	8
Interest on operating capital		.78				
Total costs per acre		23.00				

...e 8. SOLID COTTON: Weed control costs, 4-row equipment, sandy soils, Cotoran on 20-inch band.

...ation	Tractor costs		Equipment costs		Labor Costs	Materials costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
...ed Cotoran	--	--	.0...	.09	--	2.53
...ivate	.39	.25	.08	.14	.38	--
...ivate ... postemerge	.43	.27	.11	.19	.42	1.05
...ivate ... postemerge	.43	.27	.11	.19	.42	1.56
...ivate & postemerge	.37	.24	.09	.17	.36	.66
...ivate & flame	.45	.28	.11	.20	.44	.65
...ivate & postemerge	.37	.24	.09	.17	.36	2.85
... weed control	--	--	--	--	6.00	--
...otals	2.44	1.55	.63	1.15	8.38	9.30
...nterest on operating capital			.83			
...otal costs per acre			24.28			

...le 9. SOLID COTTON: Weed control costs, 4-row equipment, sandy soils, broadcast Treflan.

...cation	Tractor costs		Equipment cost		Labor costs	Materials costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
...All ... incorporate						
...erbicides	.31	.20	.12	.24	.30	2.94
...ctor ... trail ...	.10	.12	.06	.13	.10	--
...tivate	.39	.25	.08	.14	.38	--
...tivate ... postemerge	.43	.27	.11	.19	.42	1.05
...tivate ... postemerge	.43	.27	.11	.19	.42	1.56
...tivate ... postemerge	.37	.24	.09	.17	.36	.66
...tivate ... flame	.45	.28	.11	.20	.44	.65
...tivate ... postemerge	.37	.24	.09	.17	.36	2.85
...d weed control	--	--	--	--	6.00	--
...totals	2.85	1.87	.77	1.43	9.08	9.71
Interest on operating capital			.90			
Total costs per acre			26.61			

Table 10. SOLID COTTON: Weed Control costs, 4-row equipment, sandy soils broadcast Treflan + Karmex.

Operation	Tractor costs Direct	Tractor costs Fixed	Equipment costs Direct	Equipment costs Fixed	Labor costs	Mater co
	Dollars	Dollars	Dollars	Dollars	Dollars	Dol
Do All & incorporate herbicides	.31	.20	.12	.24	.30	
Tractor & trailer	.10	.12	.06	.13	.40	
Banded Karmex	--	--	.04	.09	--	
Cultivate	.39	.25	.08	.14	.38	
Cultivate & postemerge	.43	.27	.11	.19	.42	
Cultivate & postemerge	.43	.27	.11	.19	.42	
Cultivate & postemerge	.37	.24	.09	.17	.36	
Cultivate & flame	.45	.28	.11	.20	.44	
Cultivate & postemerge	.37	.24	.09	.17	.36	
Hand weed control	--	--	--	--	6.00	
Subtotals	2.85	1.87	.81	1.52	9.08	1
Interest on operating capital		.95				
Total costs per acre		28.09				

Table 11. SOLID COTTON: Weed Control costs, 4-row equipment, sandy soils broadcast Treflan + banded Cotoran.

Operation	Tractor costs Direct	Tractor costs Fixed	Equipment costs Direct	Equipment costs Fixed	Labor costs	Mate co
	Dollars	Dollars	Dollars	Dollars	Dollars	Do
Do All & incorporate Herbicides	.31	.20	.12	.24	.30	
Tractor & trailer	.10	.12	.06	.13	.40	
Banded Cotoran	--	--	.04	.09	--	
Cultivate	.39	.25	.08	.14	.38	
Cultivate & postemerge	.43	.27	.11	.19	.42	
Cultivate & postemerge	.43	.27	.11	.19	.42	
Cultivate & postemerge	.37	.24	.09	.17	.36	
Cultivate & flame	.45	.28	.11	.20	.44	
Cultivate & postemerge	.37	.24	.09	.17	.36	
Hand weed control	--	--	--	--	6.00	
Subtotals	2.85	1.87	.81	1.52	9.08	1
Interest on operating capital		1.00				
Total costs per acre		29.57				

Mississippi Cotton Variety Tests Delta And Hill Sections, 1970

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MISSISSIPPI COTTON VARIETY TESTS FOR 1970 IN THE DELTA

By ROBERT R. BRIDGE, WILLIAM R. MEREDITH, JR., and J. F. CHISM[1]

Cotton variety tests were conducted by e Delta Branch Experiment Station in 70 on the Delta Station at Stoneville, aefer Plantation near Yazoo City, tchner Plantation near Sumner and nold Farms near Tunica. Variety tests re conducted on two test sites in neville. One was on a Bosket very fine dy loam and another on a Sharkey y type soil.

Current strains of 13 varieties were own at all locations. Two varieties were sted for the first time at all locations. hese were Deltapine 6225 and Coker 0. Stoneville 7A okra leaf was tested at azoo City and Stoneville.

Results are reported at each location r the 1970 variety tests. Yield data ere based on the weight of cotton arvested from two-row plots. Each plot as randomized and replicated six times. int percentage and fiber property etermination were obtained from and-picked samples. Fiber property data ere determined by the U.S. Cotton iber Laboratory of the Crops Research ivision, Agricultural Research Service, .S. Department of Agriculture, Knoxville, Tennessee.

Performance data of varieties tested in 1970 are shown in Tables 1 through 6. Table 6 gives the average performance of 13 cotton varieties grown at five locations in 1970. Statistical analysis of the yield data for all locations indicated that the location in which a variety was grown had an effect on its yield performance. Some varieties tended to perform better at one location than they did at another location.

Table 7 gives the 6-year (1965-70) and 2-year (1969-70) average yield of cotton varieties grown at Stoneville, Yazoo City, and Tunica. Table 8 gives the 4-year (1967-70) and 2-year (1969-70) average yield at Sumner. Table 8 also gives a 3-year average yield for varieties grown on a clay soil at Stoneville.

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[1] Plant Breeder, Delta Branch Experiment Station; Research Geneticist, Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture; and Assistant Agronomist, Delta Branch Experiment Station, respectively, Stoneville, Mississippi.

Table 1. Results of 1970 cotton variety test - Stoneville, Mississippi.

	LINT PER ACRE						FIBER PROPERTIES				
			Percent			Boll	Length				
	Total	First pick	first pick	Lint percent	Seed index	size grams	2.5%	50%	Strength gms/tex	Elonga-tion	Micro-naire
Deltapine 6225	1411	1315	93	41.6	10.7	5.53	1.09	.54	18.38	7.08	5.16
Deltapine 16	1308	1219	93	39.0	11.0	6.26	1.11	.52	18.75	8.83	4.83
Stoneville 213	1305	1219	93	40.1	10.6	5.86	1.08	.51	18.10	6.95	5.16
Stoneville 7A	1304	1214	93	40.5	11.0	5.58	1.08	.51	17.21	6.47	5.10
Deltapine 45A	1285	1203	93	39.2	11.4	5.70	1.06	.54	18.63	7.87	5.06
DPL 67 213	1247	1165	93	38.2	10.9	5.74	1.11	.53	17.19	7.56	4.75
Coker 201	1230	1140	93	38.6	11.9	6.12	1.12	.54	18.08	6.81	4.69
Coker 310	1167	1113	94	37.5	12.2	6.45	1.16	.53	18.23	7.07	4.63
Stoneville 7A Okra	1164	1102	95	38.5	10.6	5.72	1.06	.52	17.57	6.57	4.87
Coker 417	1157	1078	93	36.9	11.8	5.98	1.19	.53	18.87	7.23	4.25
Stoneville 603	1127	1058	94	36.4	12.0	5.67	1.14	.54	20.29	7.56	4.37
Delcot 277	1122	1066	95	36.3	12.9	6.77	1.19	.59	20.91	9.03	4.10
Acala SJ-1	976	868	89	36.3	13.7	6.65	1.14	.57	22.53	6.48	4.72
Paymaster 111	855	763	89	35.5	12.7	7.54	1.07	.52	18.76	6.34	4.73

Planted: April 23, 1970
Harvested: September 29 and October 30, 1970
Soil: Bosket very fine sandy loam

Table 2. Results of 1970 cotton variety test - Tunica, Mississippi.

	LINT PER ACRE	Lint percent	Seed index	Boll size grams	FIBER PROPERTIES				
					Length 2.5%	Length 50%	Strength gms/tex	Elongation	Micronaire
Deltapine 15	902	37.9	12.0	6.37	1.18	.57	18.04	8.09	4.65
Stoneville 603	861	36.0	12.9	6.33	1.15	.56	19.11	7.34	4.52
Deltapine 45A	843	37.7	12.1	6.21	1.13	.56	18.64	7.16	4.82
Deltapine 6225	835	39.6	11.5	5.76	1.16	.56	19.43	6.64	4.82
Coker 310	824	38.2	12.1	5.99	1.23	.58	18.62	6.96	4.57
Stoneville 213	789	37.0	12.4	6.37	1.17	.57	18.29	7.03	4.90
DES 67-213	780	37.1	11.6	6.08	1.13	.54	17.65	7.00	4.61
Stoneville 7A	778	37.7	11.8	5.96	1.16	.54	17.97	5.90	4.74
Delcot 277	764	36.6	13.1	6.80	1.21	.59	20.50	8.17	4.02
Coker 417	668	37.0	12.3	6.07	1.21	.58	19.26	6.51	4.44
Coker 201	594	37.8	13.0	6.17	1.15	.55	18.11	6.31	4.72
Paymaster 111	557	35.3	13.6	7.20	1.07	.54	18.74	6.10	4.59
Acala SJ-1	501	35.5	15.0	7.12	1.16	.57	21.54	5.81	4.63

Planted: May 7, 1970
Harvested: November 25, 1970

Table 3. Results of 1970 cotton variety test - Stoneville, Mississippi - Sharley clay soil.

	LINT PER ACRE	Lint percent	Seed index	Boll size grams	FIBER PROPERTIES				
					Length 2.5%	Length 50%	Strength gms/tex	Elongation	Micronaire
Deltapine 45A	466	39.4	10.3	4.78	1.09	.54	19.27	8.37	4.88
Deltapine 6225	438	40.3	10.3	4.72	1.13	.56	20.47	7.32	4.89
Deltapine 16	427	37.5	11.0	5.17	1.13	.54	19.87	9.05	4.90
Coker 310	403	37.8	11.9	5.41	1.21	.57	19.62	6.56	4.87
Stoneville 603	391	35.6	11.8	4.94	1.15	.57	19.74	7.69	4.45
Coker 201	372	38.5	11.5	5.17	1.13	.55	20.10	6.53	4.78
DES 67-213	370	37.1	10.9	4.95	1.16	.57	17.44	7.99	4.59
Coker 417	348	36.6	11.7	5.17	1.19	.58	19.61	6.83	4.38
Stoneville 7A	346	39.7	10.6	4.92	1.14	.55	18.83	6.09	5.01
Stoneville 213	311	37.6	11.1	5.12	1.12	.55	18.60	7.14	4.94
Delcott 277	311	36.0	13.2	5.53	1.19	.59	20.46	9.08	4.19
DES 217-11-11	307	36.0	11.6	5.61	1.16	.58	19.18	6.78	4.72
Acala SJ-1	269	35.1	14.7	5.59	1.17	.61	25.49	6.65	4.63
Paymaster 111	252	35.9	12.7	5.80	1.09	.55	20.37	6.12	4.77

Planted: April 14, 1970
Harvested: October 5, 1970

Table 4. Results of 1970 Cotton Variety Test - Sumner, Mississippi.

	LINT PER ACRE	Lint percent	Seed index	Boll size grams	FIBER PROPERTIES				
					Length		Strength	Elonga-	Micro-
					2.5%	50%	grs/tex	tion	naire
Deltapine 6225	1359	40.8	11.3	5.51	1.14	.57	17.78	7.61	4.66
Deltapine 16	1357	39.9	11.7	6.44	1.17	.59	17.51	8.67	4.81
Stoneville 213	1356	39.2	11.8	6.27	1.13	.57	17.25	7.82	4.90
Coker 310	1345	38.7	12.2	5.96	1.23	.58	18.32	7.56	4.46
Deltapine 45A	1339	40.4	11.4	5.65	1.13	.55	17.74	8.23	4.52
Stoneville 7A	1329	39.7	11.3	6.00	1.15	.56	17.87	7.18	4.81
Coker 417	1320	38.1	12.1	6.17	1.20	.60	18.21	7.03	4.28
DES 67-213	1277	38.6	11.5	5.74	1.13	.55	16.88	8.18	4.60
Stoneville 603	1259	36.6	12.8	6.03	1.14	.56	18.18	8.10	4.57
Coker 201	1253	39.3	12.3	5.98	1.15	.57	16.94	7.63	4.53
DES 217-11-11	1252	37.9	12.2	5.78	1.16	.57	18.28	7.62	4.55
Delcot 277	1142	37.6	13.6	6.73	1.20	.59	18.91	8.94	3.97
Acala SJ-1	1007	35.6	14.5	6.73	1.19	.60	21.42	7.49	4.21
Paymaster 111	963	35.8	14.3	7.46	1.10	.53	17.98	7.41	4.69

Planted: May 6, 1970
Harvested: November 24, 1970

Table 5. Results of 1970 Cotton Variety Test - Yazoo City, Mississippi.

	LINT PER ACRE	Lint percent	Seed index	Boll size grams	FIBER PROPERTIES				
					Length		Strength	Elonga-	Micro-
					2.5%	50%	gms/tex	tion	naire
Deltapine 45A	1011	38.5	11.6	6.03	1.14	.57	18.32	6.78	4.67
Stoneville 213	1004	37.4	11.6	6.04	1.17	.58	19.07	7.16	4.87
DES 67-213	998	36.9	11.2	5.71	1.14	.55	17.50	7.68	4.46
Deltapine 16	997	38.0	11.4	6.42	1.20	.59	18.82	8.39	4.91
Coker 417	995	36.1	12.5	6.01	1.25	.60	18.93	6.32	4.30
Deltapine 6225	984	40.0	11.0	5.73	1.17	.57	19.52	7.38	4.97
Coker 310	955	38.2	12.4	6.16	1.25	.62	18.55	6.62	4.66
Stoneville 7A	932	37.6	11.8	5.77	1.20	.59	18.29	6.46	4.67
Coker 201	859	37.9	12.2	6.10	1.19	.57	18.35	6.54	4.67
Stoneville 7A Okra	856	36.9	11.6	5.91	1.15	.56	17.53	5.73	4.83
Stoneville 603	854	34.9	12.9	6.08	1.18	.60	19.24	7.38	4.37
Acala SJ-1	784	35.2	14.1	7.28	1.18	.61	22.36	6.93	4.40
Delcot 277	780	36.0	13.3	6.66	1.24	.62	19.97	7.80	4.17
Paymaster 111	527	34.5	13.7	7.31	1.12	.56	18.72	6.32	4.52

Planted: April 30, 1970
Harvested: November 10, 1970

Table 6: Average performance of 13 cotton varieties grown at five locations in 1970

	Lint Per Acre	Lint Percent	Seed Index	Boll Size	FIBER PROPERTIES Length 2.5%	Strength g/tex	Elongation E,	Micronaire
Deltapine 6225	1005	40.4	11.0	5.45	1.138	19.11	7.21	4.90
Deltapine 16	998	38.4	11.4	6.13	1.158	18.60	8.61	4.82
Deltapine 45A	989	39.0	11.4	5.67	1.[illegible]	18.52	7.68	4.79
Stoneville 213	953	38.3	11.5	5.93	1.[illegible]	18.26	7.22	4.95
Coker 310	943	38.1	12.1	5.99	1.216	18.67	6.95	4.64
Stoneville 7A	938	39.0	11.3	5.64	1.146	18.03	6.42	4.87
D&S 67-213	934	37.6	11.2	5.64	1.134	17.33	7.68	4.60
Coker 417	898	36.9	12.1	5.88	1.208	18.97	6.78	4.33
Stoneville 603	898	35.9	12.5	5.81	1.152	19.31	7.61	4.45
Coker 201	862	38.4	12.2	5.91	1.148	18.32	6.76	4.68
Delcot 277	824	36.5	13.2	6.50	1.206	20.15	8.60	4.09
Acala SJ-1	707	35.5	14.4	6.67	1.168	22.67	6.67	4.52
Paymaster 111	631	35.4	13.4	7.06	1.090	18.91	6.46	4.66

Table 7: Cotton variety tests at three Delta locations (Stoneville, Yazoo City, Tunica) 1965-1970

Stoneville, Miss. (Sandy Loam)	1965	1966	1967	1968	1969	1970	6-Year Average 1965-70	2-Year Average 1969-70
Deltapine 16	1200	1014	1040	1198	851	1308	1102	1079
Stoneville 213	1231	1000	984	1154	893	1305	1094	1099
Deltapine 45A	1176	989	1004	1130	891	1285	1079	1088
Stoneville 7A	1281	924	939	1128	770	1304	1058	1037
Coker 201	1008	930	878	997	729	1230	962	979
Delcot 277	--	--	--	--	788	1122	--	955
Stoneville 603	--	--	--	--	779	1127	--	953
Coker 417	--	--	--	--	660	1157	--	908
Yazoo City, Miss.								
Stoneville 213	1024	793	1117	1432	440	1004	968	722
Stoneville 7A	967	779	1094	1416	480	932	945	706
Deltapine 16	920	790	1114	1341	362	997	921	680
Deltapine 45A	903	769	1079	1259	377	1011	900	690
Coker 201	1083	745	1132	1238	323	859	897	591
Coker 417	--	--	--	--	387	995	--	691
Stoneville 603	--	--	--	--	391	854	--	622
Delcot 277	--	--	--	--	345	780	--	562
Tunica, Miss.								
Deltapine 16	926	1060	1010	--	663	902	912	782
Deltapine 45A	934	992	995	--	650	843	883	746
Stoneville 213	892	1009	969	--	720	789	876	754
Stoneville 7A	847	1031	914	--	719	778	858	748
Coker 201	826	935	1005	--	669	594	806	631
Stoneville 603	--	--	--	--	711	861	--	786
Delcot 277	--	--	--	--	575	764	--	669
Coker 417	--	--	--	--	624	668	--	646

Table 8: Cotton variety tests at two Delta locations (Sumner and Stoneville) 1967-1970

Sumner, Miss.	1967	1968	1969	1970	4-Year Average 1967-70	2-Year Average 1969-70
Deltapine 45A	1479	1151	1167	1339	1284	1253
Deltapine 16	1514	1111	1151	1357	1283	1254
Stoneville 213	1415	1135	1140	1356	1261	1248
Coker 201	1510	1111	1111	1253	1246	1182
Stoneville 7A	1391	1068	1070	1329	1214	1200
Coker 417	--	--	1138	1320	--	1229
Stoneville 603	--	--	1106	1259	--	1182
Delcot 277	--	--	1012	1142	--	1077
Stoneville, Miss. (Clay Soil)						
Deltapine 45A	--	1081	758	466	768	612
Deltapine 16	--	1056	757	427	747	592
Stoneville 213	--	1034	742	311	695	526
Stoneville 7A	--	986	596	346	643	471
Coker 201	--	974	496	372	614	434
Delcot 277	--	--	704	311	--	507
Coker 417	--	--	634	348	--	491
Stoneville 603	--	--	524	391	--	457

COTTON TESTS IN HILL SECTION

A. G. DOUGLAS, J. A. ANDRIES, R. C. ALBRITTON, S. P. CROCKETT, N. C. EDWARDS, B. C. HURT, JR., and ROSCOE IVY[1]

Performance of 15 cotton varieties was evaluated at seven locations in the Hill Section of Mississippi in 1970. Three varieties were tested for the first time. These were Deltapine 6225, produced by the Delta and Pine Land Company, Scott, Mississippi; Stoneville 603, produced by Stoneville Pedigreed Seed Company, Stoneville, Mississippi; and Frego, an experimental strain. Varieties which were previously tested, but omitted from the 1970 tests were Stoneville 508, Dunn 56C, and Hybee 200.

Insect infestation at all locations were generally light. Boll weevil populations did not reach damaging levels until late in the season. Bollworms and plant bugs caused some damage at some locations early in the season, but this damage was generally light.

Weather conditions were generally good throughout the growing season, and relatively high yields were obtained. Cool, wet weather delayed planting at some locations, but planting dates at all locations were still well within the optimum dates. Wet weather beginning at about the time of crop maturity delayed harvest two to six weeks at most locations and may have adversely affected yield at these locations.

Performance data for the 15 varie tested in 1970 and three year averages varieties tested during 1968-70 are gi in the accompanying tables. Yield yield components reported include, per acre, lint percentage, and boll s Since once-over harvesting has b common at most locations for rec years, percent of the crops obtainec the first harvest, used as a measure earliness of maturity, has been omit from this report.

Classers staple length in 32nds inch micronaire were provided for each vari at each location by the U.S.D.A. Cot Classing Office, Jackson, and are give the tables. In addition, results of fi analyses are given for two locations. Fi data reported include strength thousand pounds per square inch ten strength; 2.5% span length; uniformity ratio.

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[1] Cotton variety testing is a coopera project involving the Central Station at S College and branch stations. The auth represent the Agronomy Department at S College and Branch Experiment Station Verona, , Holly Springs, Raymond, Pontc and Brooksville.

ree year average lint yield of 12 cotton varieties tested at 7 locations in the ll Section, 1968-70.

verages riety	State College	Brooks-ville	Raymond	Pontotoc Ridge	Holly Springs Bottom	Holly Springs Hill	Verona*	Average
toneville 213	886	796	1144	825	792	755	926	875
ancock	779	839	879	881	770	696	865	816
eltapine 16	805	714	1025	843	800	662	834	812
toneville 7A	780	719	1000	816	761	714	864	808
ixie King II	715	773	946	877	729	700	796	791
oker 201	790	676	992	845	785	637	789	788
ybee 401	811	724	894	773	719	611	916	778
oker 310*	696	667	836	742	875	682	863	766
eltapine 45A	795	741	902	811	727	617	757	764
cNair 1032B	762	655	907	782	727	654	742	747
oker 417*	639	625	819	745	808	672	872	740
o-Del	659	691	890	755	685	597	743	717
Average	760	718	936	808	765	666	831	784

Two year average 1969 and 1970.

int yield, in pounds per acre, of 15 cotton varieties tested at 7 locations in the ill Section in 1970.

Averages ariety	State College	Brooks-ville	Raymond	Pontotoc Ridge	Holly Springs Bottom	Holly Springs Hill	Verona	Average
toneville 213	609	789	1072	873	845	741	1025	851
oker 310	611	816	973	904	1021	632	936	842
eltapine 16	644	702	1071	977	969	606	903	839
eltapine 6225	608	810	990	921	944	677	879	833
ancock	706	853	795	921	880	697	944	828
toneville 603	514	913	924	925	858	683	944	823
oker 417	562	722	952	893	975	650	932	812
toneville 7A	477	778	903	913	914	735	932	807
oker 201	650	728	989	982	823	585	855	802
ixie King II	364	824	873	944	840	734	859	777
ybee 401	630	751	915	848	816	571	880	773
cNair 1032B	408	731	833	969	871	673	820	758
eltapine 45A	604	786	832	929	804	534	776	752
o-Del	452	766	915	789	754	617	721	719
rego	494	772	686	536	--	--	695	637
Average	555	784	914	868	879	613	873	790

Cotton variety performance at the Black Belt Branch Experiment Station, Brooksvill in 1970.

Black Belt Variety	Lint/ Acre	Lint %	Bolls/lb. Seed Cot.	Bolls/lb. Lint	Fiber Propert Staple	Fiber Propert M
	Lbs.	%	No.	No.	1/32 in.	In
Stoneville	913	37.4	77	212	34	
Hancock	852	37.9	63	241	34	
Dixie King II	824	37.7	57	150	34	
Coker 310	816	38.8	77	198	35	
Deltapine 6225	810	39.1	80	202	34	
Stoneville 213	789	37.5	72	193	35	
Deltapine 45A	786	37.9	77	207	34	
Mo-Del	786	35.2	67	193	34	
Stoneville 7A	778	38.1	73	192	35	
Frego	772	35.6	73	210	34	
Hybee 401	751	37.3	77	210	34	
McNair 1032B	731	37.1	82	218	34	
Coker 201	728	38.8	70	183	35	
Coker 417	722	36.3	68	193	35	
Deltapine 16	702	35.3	77	218	35	
Average	784	37.3	72	201	34.4	
L.S.D. @ .05	166					
@ .01	218					
C.V.	5.9%					

Three year averages, Black Belt Branch Experiment Station, Brooksville, in 1970.

Variety	Lint/ Acre	Lint %	Bolls/lb. Seed Cot.	Bolls/lb. Lint	Fiber Propert Staple	Fiber Propert M
	Lbs.	%	No.	No.	1/32 in.	In
Hancock	839	38.6	71	208	33	
Stoneville 213	796	38.4	84	219	34	
Dixie King II	773	38.2	68	177	34	
Deltapine [illegible]	741	38.[illegible]	87	226	34	
Hybee 401	724	37.9	82	217	34	
Stoneville [illegible]	719	38.5	85	221	35	
Deltapine [illegible]	714	37.5	85	225	34	
Mo-Del	691	36.0	74	207	34	
Coker 201	6[illegible]6	[illegible].3	83	211	34	
Coker 310*	667	41.6	87	209	35	
McNair 1032B	655	37.[illegible]	90	238	34	
Coker 417*	625	37.[illegible]	82	221	35	
Average	718	38.3	82	21[illegible]	34	

* Two year average, 1969 and 1970.

Cotton variety performance at the Northeast Mississippi Branch Experiment Station, Verona, in 1970.

Northeast Mississippi Variety	Lint/ Acre	Lint %	Bolls/lb. Seed Cot.	Bolls/lb. Lint	Fiber Properties Staple	Fiber Properties Mike
	Lbs.	%	No.	No.	1/32 in.	Index
Stoneville 213	1025	38.7	83	215	34.3	4.7
Alcock	944	38.5	73	192	34.0	4.3
Stoneville 603	944	36.6	83	228	35.0	4.5
Deer 310	936	37.9	85	230	35.3	4.1
Stoneville 7A	932	40.2	85	212	34.3	4.7
Deer 417	932	36.9	80	218	35.3	4.1
Mitapine 16	903	37.9	83	228	35.0	4.3
Bobee 401	880	38.2	83	220	34.3	4.2
Mitapine 6225	879	40.2	87	217	35.0	4.7
Dixie King II	859	36.6	58	165	34.0	4.5
Deer 201	855	39.8	80	207	35.0	4.3
Delnair 1032B	820	37.5	93	250	34.3	4.3
Mitapine 45A	776	36.8	83	228	34.3	4.8
Ark-Del	721	35.2	73	212	34.7	4.6
Virgo	695	35.6	80	232	34.0	4.5
Average	860	37.7	80	216	34.5	4.4
L.S.D. @ .05	147					
@ .01	193					
C.V.	14.8%					

Two year averages, Northeast Branch Experiment Station, Verona, 1969 and 1970.

Variety	Lint Acre	Lint %	Bolls/lb. Seed Cot.	Bolls/lb. Lint	Fiber Properties Staple	Fiber Properties Mike
	Lbs.	%	No.	No.	1/32 in.	Index
Stoneville 213	926	39.3	82	209	34.5	5.0
Bobee 401	916	39.3	81	207	34.5	4.7
Deer 417	872	37.6	80	212	35.0	4.4
Alcock	865	39.6	72	184	33.8	4.6
Stoneville 7A	864	40.1	84	209	34.5	4.9
Deer 310	863	39.2	82	213	35.2	4.4
Mitapine 16	834	38.9	86	224	35.2	4.5
Dixie King II	796	37.7	61	165	34.0	4.8
Deer 201	789	40.5	77	193	34.7	4.7
Mitapine 45A	757	38.3	82	216	34.3	5.0
Ark-Del	743	36.5	72	199	34.9	4.9
Delnair 1032B	742	38.2	89	233	34.5	4.5
Average	831	38.8	79	205	34.6	4.7

Cotton variety performance at the Central Station, State College, in 1970.

State College Variety	Lint Acre	Lint %	Bolls/lb.		Fiber Properties				
			Seed Cot.	Lint	Staple	Mike	Strength	2.5% Span	U.R.
	Lbs.	%	No.	No.	1/32 in.	Index	M.P.S.I.	In.	%
Hancock	706	36.0	67	190	34.3	4.1	84	1.12	46
Coker 100	650	36.7	78	215	34.3	3.9	83	1.17	45
Deltapine 16	644	35.5	77	220	36.0	3.8	73	1.19	45
Hybee 401	630	39.1	77	200	35.7	4.1	79	1.21	46
Coker 310	611	37.1	75	206	35.7	4.2	84	1.24	44
Stoneville 212	609	36.0	78	223	35.3	4.4	81	1.17	47
Deltapine 6225	608	38.4	77	205	35.3	4.3	86	1.18	47
Deltapine 45A	604	38.0	77	210	35.7	4.2	82	1.14	46
Coker 417	562	35.7	72	210	35.7	3.9	86	1.21	45
Stoneville 603	514	34.2	80	237	35.0	4.2	84	1.19	47
Frego	494	33.7	78	240	35.3	3.7	87	1.16	44
Stoneville 7A	477	36.1	82	228	36.0	4.2	87	1.21	46
Mo-Del	452	33.1	65	202	35.3	4.2	81	1.15	47
McNair 1032B	408	36.0	85	243	35.3	4.1	86	1.10	48
Dixie King II	364	34.5	58	173	34.3	3.7	86	1.13	45
Average	556	36.0	75	213	35.3	4.1	83	1.17	46
L.S.D. @ .05	161								
@ .01	212								
C.V.	25.6%								

Three year averages, Central Station, State College, 1968-70.

Variety	Lint/ Acre	Lint	Bolls/lb.		Fiber Properties				
			Seed Cot.	Lint	Staple	Mike	Strength	2.5% Span	U.R.
	Lbs.	%	No.	No.	1/32 in.	Index	M.P.S.I.	In.	%
Stoneville 213	886	38.1	77	206	34.4	4.7	84	1.14	48
Hybee 401	812	39.0	77	199	34.5	4.5	86	1.13	47
Deltapine 16	805	37.6	78	209	34.8	4.3	78	1.15	46
Deltapine 45A	795	38.5	76	200	34.3	4.6	84	1.12	48
Coker 201	790	39.3	76	194	34.1	4.4	87	1.12	47
Stoneville 7A	780	37.9	79	210	34.9	4.6	89	1.17	46
Hancock	779	38.9	70	181	33.4	4.2	88	1.08	46
McNair	762	37.8	79	213	34.0	4.7	90	1.08	48
Dixie King II	715	37.7	63	169	33.7	4.2	87	1.10	46
Coker 310*	696	38.2	81	2.4	35.7	4.4	87	1.20	47
Mo-Del	659	36.0	70	195	34.4	4.1	88	1.12	48
Coker 417*	639	36.8	77	214	35.0	4.2	90	1.17	46
Average	759	37.9	75	200	34.4	4.4	86	1.13	46

* Two year average, 1969 and 1970.

Cotton variety performance at the Brown Loam Branch Experiment Station, Raymond, in 1970.

Brown Loam Variety	Lint/Acre	Lint %	Bolls/lb.		Fiber Properties				
			Seed Cot.	Lint	Staple	Mike	Strength	2.5% Span	U.R.
	Lbs.	%	No.	No.	1/32 in.	Index	M.P.S.I.	In.	%
Stoneville 213	1072	40.8	78	193	33.7	5.3	86	1.09	50
Deltapine 16	1071	43.5	77	179	34.3	5.3	80	1.09	49
Deltapine 6225	990	41.2	77	188	34.0	5.2	85	1.08	50
Coker 201	989	40.3	77	193	34.0	5.4	88	1.06	50
Coker 310	973	41.1	73	178	34.3	5.1	88	1.10	49
Coker 417	952	38.7	71	186	33.3	5.2	87	1.06	50
Stoneville 603	924	38.7	80	207	33.7	5.5	85	1.09	50
Hybee 401	915	40.0	68	171	34.3	5.4	82	1.09	49
Mo-Del	915	38.4	69	180	34.3	5.4	88	1.10	49
Stoneville 7A	903	40.1	79	198	34.3	5.5	87	1.10	49
Dixie King II	873	37.1	68	183	34.3	5.4	84	1.05	50
McNair 1032B	833	38.0	81	2.5	34.0	5.3	87	1.11	50
Deltapine 45A	832	39.9	74	187	33.7	5.5	82	1.07	50
Hancock	795	41.0	77	189	34.0	5.0	86	1.10	50
Frego	686	38.1	79	208	34.0	5.2	86	1.06	48
Average	915	39.8	75	190	34.0	5.3	85	1.08	50
L.S.D. @ .05	138								
@ .01	181								
C.V.	13.2%								

Three year averages, Brown Loam Branch Experiment Station, Raymond, 1968-70.

Variety	Lint/ Acre	Lint %	Bolls/lb.		Fiber Properties				
			Seed Cot.	Lint	Staple	Mike	Strength	2.5% Span	U.R.
	Lbs.	%	No.	No.	1/32 in.	Index	M.P.S.I.	In.	%
Stoneville 213	1144	39.5	80	203	33.5	5.0	88	1.08	49
Deltapine 16	1025	39.7	78	200	34.0	4.8	85	1.08	48
Stoneville 7A	1000	39.3	84	214	33.5	5.1	92	1.09	47
Coker 201	992	40.7	76	189	33.8	5.2	90	1.06	48
Dixie King 11	946	37.3	69	186	33.8	5.0	87	1.05	49
McNair 1032B	907	37.5	81	219	33.3	4.9	91	1.06	49
Deltapine 45A	902	38.6	78	205	33.7	5.0	85	1.05	50
Hybee 401	894	38.8	73	190	33.9	5.1	91	1.07	48
Mo-Del	890	37.4	71	191	34.1	5.0	89	1.08	49
Hancock	879	40.1	76	192	33.1	4.9	88	1.04	48
Coker 310*	836	39.5	81	208	34.2	4.8	89	1.14	49
Coker 417*	819	36.9	82	224	33.8	4.6	91	1.11	49
Average	936	38.7	77	201	33.7	4.9	88	1.07	48

* Two year average, 1969 and 1970.

Cotton variety performance at the North Mississippi Branch Experiment Station, Ho
Springs, on hill land, 1970.

North Misissippi, Hill Land	Lint/ Acre	Lint %	Bolls/lb.		Fiber Proper	
			Seed Cot.	Lint	Staple	
	Lbs.	%	No.	No.	1/32 in.	In
Stoneville 213	741	43.2	77	182	33.7	
Stoneville 7A	735	43.6	80	182	34.3	
Dixie King II	734	48.6	67	142	33.3	
Hancock	697	44.5	73	170	33.3	
Stoneville 603	683	40.3	88	218	34.3	
Deltapine 6225	677	44.5	88	198	34.3	
McNair 1032B	673	42.6	83	197	33.3	
Coker 417	650	42.2	75	182	34.3	
Coker 310	632	43.9	75	172	34.3	
Mo-Del	617	40.3	73	183	34.3	
Deltapine 16	606	43.3	82	188	34.3	
Coker 201	585	43.9	85	197	34.3	
Hybee 401	571	42.5	80	188	34.0	
Deltapine 45A	534	42.1	82	197	34.0	
Average	653	43.3	79	185	34.0	
L.S.D. @ .05	88					
@ .01	116					
C.V.	11.8%					

Three year averages, North Mississippi Branch Experiment Station, Holly Springs, C
hill land, 1968-70.

Variety	Lint/ Acre	Lint	Bolls/lb.		Fiber Properti	
			Seed Cot.	Lint	Staple	
	Lbs.	%	No.	No.	1/32 in.	In
Stoneville 213	755	41.9	84	202	34.0	
Stoneville 7A	714	41.5	86	208	34.0	
Dixie King II	700	43.1	72	172	33.0	
Hancock	696	43.0	79	188	33.0	
Coker 310*	682	42.8	94	130	34.7	
Coker 417*	672	41.2	79	190	34.2	
Deltapine 16	662	41.8	85	204	33.6	
McNair 1032B	654	41.1	91	220	33.2	
Coker 201	637	42.9	90	210	33.4	
Deltapine 45A	617	41.3	90	219	33.4	
Hybee 401	611	39.6	88	224	33.7	
Mo-Del	597	39.2	80	205	33.8	
Average	669	41.6	91	179	33.6	

* Two year average, 1969 and 1970.

Cotton variety performance at the North Mississippi Branch Experiment Station, Holly Springs, on bottom land in 1970.

North Mississippi, Bottom Land	Lint Acre	Lint %	Bolls/lb. Seed Cot.	Bolls/lb. Lint	Fiber Properties Staple	Fiber Properties Mike
	Lbs.	%	No.	No.	1/32 in.	Index
Coker 310	1021	42.6	75	183	35.0	4.9
Coker 417	975	40.7	75	185	34.8	5.0
Deltapine 16	969	39.6	67	180	35.7	4.2
Deltapine 62-5	944	40.1	77	192	35.0	4.8
Stoneville 7A	914	39.2	55	145	34.0	4.8
Hancock	880	37.5	68	185	35.0	4.5
Mo-Ir 1[illegible]	871	39.0	85	220	34.3	4.6
Stoneville 603	858	40.1	70	175	34.8	4.9
Stoneville 213	845	39.8	76	187	34.9	4.8
Delta King II	840	40.3	64	163	34.0	4.3
Coker 201	823	40.3	78	195	34.5	4.9
Hyper 401	816	37.4	73	198	35.3	4.3
Deltapine 40A	804	40.8	78	190	34.8	4.7
Model	754	40.2	77	190	35.3	4.9
Average	880	39.9	73	185	34.8	4.7
L.S.D. @ .05	146					
@ .01	197					
C.V.	15.2%					

The year averages, North Mississippi Branch Experiment Station, Holly Springs, on bottom land, 1968-70.

Variety	Lint/ Acre	Lint	Bolls/lb. Seed Cot.	Bolls/lb. Lint	Fiber Properties Staple	Fiber Properties Mike
	Lbs.		No.	No.	1/32 in.	Index
Coker 310*	875	40.9	80	200	35.0	4.9
Coker 417*	808	39.2	78	201	34.8	4.7
Deltapine 16	800	39.3	72	188	34.[illegible]	4.7
Stoneville 213	792	39.2	82	208	34.3	4.8
Coker 201	[illegible]	41.2	79	190	34.0	5.0
Hancock	770	38.8	71	185	33.9	4.5
Model	761	38.8	76	197	34.1	4.9
Delta King II	729	39.3	68	174	33.7	4.7
Deltapine 40A	727	39.[illegible]	82	208	34.1	4.9
Mo-Ir [illegible]	727	38.8	84	219	33.7	4.8
Hyper 401	719	38.[illegible]	77	199	34.2	4.8
Coker [illegible]	[illegible]	38.[illegible]	78	201	34.3	4.8
Average	765	39.3	77	197	34.2	4.7

Two year average, 1969 and 1970.

Cotton variety performance at the Pontotoc Branch Experiment Station, Pontotoc, o ridge soil, in 1970.

Pontotoc, Ridge Variety	Lint/ Acre	Lint %	Bolls/lb. Seed Cot.	Bolls/lb. Lint	Fiber Proper Staple	Fiber Proper ke
	Lbs.	%	No.	No.	1/32 in.	In
Coker 201	982	42.7	71	165	34.0	.2
Deltapine 16	977	42.9	75	174	34.0	.7
McNair 1032B	969	41.5	77	186	33.0	.3
Dixie King II	944	42.0	56	133	33.3	.3
Deltapine 45A	929	42.1	76	179	33.7	.6
Stoneville 603	925	40.2	75	186	34.0	.1
Deltapine 6225	921	44.4	78	175	34.0	.7
Hancock	921	43.4	66	152	33.0	.1
Stoneville 7A	913	42.6	75	177	34.0	.6
Coker 310	904	41.2	71	173	34.0	.4
Coker 417	893	41.5	69	167	34.0	.9
Stoneville 213	873	42.3	72	172	33.7	.6
Hybee 401	848	41.6	70	167	33.7	.3
Mo-Del	789	39.9	66	164	34.0	.0
Frego	536	38.2	81	212	34.0	.0
Average	8[illegible]	41.[illegible]	72	17[illegible]	33.[illegible]	.3
L.S.D. @ .05	105					
@ .01	138					
C.V.	[illegible]					

Three year averages, Pontot[illegible] Branch Experiment Station, Pontotoc, on ridge soil, [illegible]

[illegible]	[illegible]	[illegible]	Bolls/lb. Seed Cot.	Bolls/lb. Lint	Fiber Properties Staple	Fiber Properties [illegible]
			No.	No.	1/32 [illegible]	In
[illegible]	[illegible]	[illegible]	72	[illegible]	33.9	8
[illegible]	[illegible]	41.2	[illegible]	[illegible]	33.1	0
[illegible]	845	[illegible]	78	[illegible]	33.3	0
Deltapine	84[illegible]	41.3	77	188	[illegible]	2
Stoneville	825	41.3	79	191	33.6	4
[illegible]	[illegible]	40.9	[illegible]	[illegible]	33.7	4
[illegible]	811	[illegible]	[illegible]	19[illegible]	[illegible]	1
[illegible]	[illegible]	[illegible]	74	1[illegible]	33.6	1
[illegible]	[illegible]	40.1	83	209	33.2	1
[illegible]	[illegible]	38.4	72	[illegible]	33.4	7
[illegible]	[illegible]	[illegible]	79	199	34.2	6
Coker 310*	[illegible]	40.1	83	207	34.2	3
[illegible]	[illegible]	[illegible]	76	189	33.5	0

* Two year average, 1969 and 1970.

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FORE$TRY: ITS ECONOMIC IMPORTANCE TO MISSISSIPPI

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HIGHLIGHTS

56 percent of the total land area in Mississippi is commercial forest land.

75 percent of commercial forest land is owned by non-industrial private owners.

Total growing stock on commercial forest land in 1970 was 13.5 billion cubic feet which included 42.8 billion board feet of sawtimber.

Growth on growing stock in 1969 was 886 million cubic feet which included 2.8 billion board feet of sawtimber.

Timber removed from growing stock in 1969 was 969.9 million cubic feet which included 3.6 billion board feet of sawtimber. (290 million cubic feet were damaged by hurricane Camille and is considered as a reduction in inventory).

36 percent of all manufacturing plants are timber-based.

28 percent of all manufacturing employment is in timber-based plants.

26 percent of all manufacturing payrolls are in timber-based plants.

23 percent of all value added in manufacturing is in timber-based plants.

64,280 full time jobs in 1968 were provided by timber-based economic activities.

$318 million in annual payrolls were provided by timber-based activities in 1968.

$618 million in value added originated in timber-based economic activities in 1968.

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INTRODUCTION

There is a constant need for some measure of the magnitude and importance of forestry activities in the state of Mississippi. This work is an effort to bring together at one period in time information relating to the major elements associated with growing timber and the processing and utilization of timber products.

These elements are **LAND, TIMBER, EMPLOYMENT, PAYROLLS, VALUE AND, VALUE OF SHIPMENTS.** Land is the basic resource from which all of the timber related activities spring and the growing stock or inventory is the key factor in timber growth. In showing the economic importance of timber, four widely accepted measures of economic activity were chosen. Employment, payrolls, value added, and value of shipments are estimated within progressive stages along the processing and utilization chain. These stages are **forest management, harvesting, manufacturing,** and a group consisting of **construction, transportation,** and **marketing.**

Most of the data are for 1968, but when they are not the date will be indicated. Timber inventory and growth figures are more recent.

A much more comprehensive and basic work was done covering similar data for the United States, by states, for the years 1954 and 1958 by Hair (3).

Definition of terms and detailed procedures are found in the appendix.

LAND

FORESTRY is by far the dominant land use in Mississippi. Commercial forest land accounts for 56 percent of the total land area while farm land, including pasture land, makes up 34 percent of the total. Urban and miscellaneous uses cover the remaining 10 percent. Commercial forest acreage has fluctuated somewhat over the past three decades, being 52 percent in 1935, 54 percent in 1948, 57 percent in 1957, and dropping back to 56 percent in 1967. This drop was mainly due to heavy land clearing in the Delta (7).

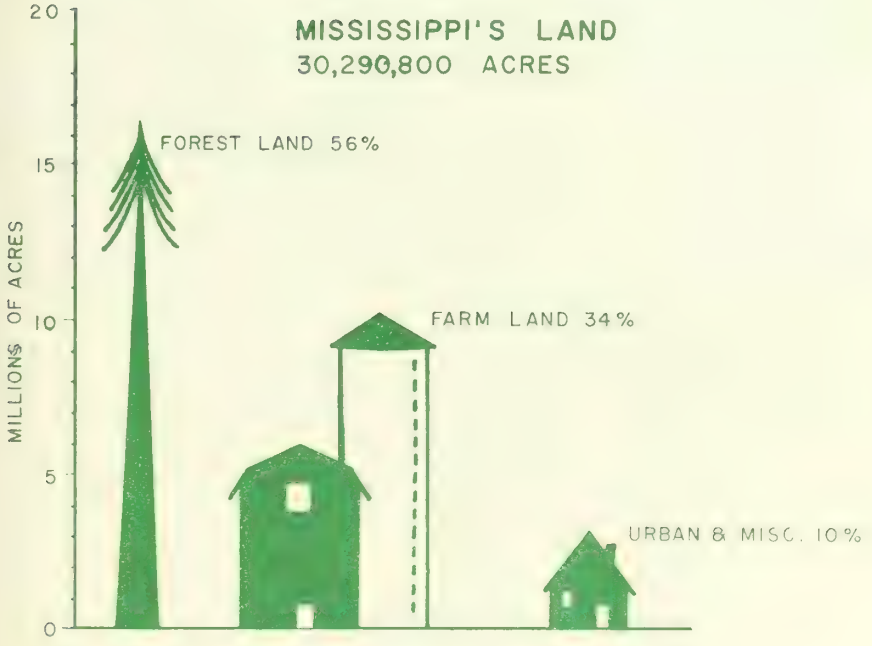

Figure 1. Land use in Mississippi, 1967.

source: see table 2 in appendix.

OWNERSHIP of the forest land is predominantly in the hands of non-industrial private individuals who own three-fourths of the total. Farmers with 37 percent own over twice that of forest industry which owns only 15 percent. Other private, non-industrial, owners hold 38 percent. The remaining 10 percent is in public ownership, over half of which is in National Forests. Both public and forest industry ownerships have remained almost the same during the last ten years while a million acres has shifted from farmers to non-farm non-industrial private owners.

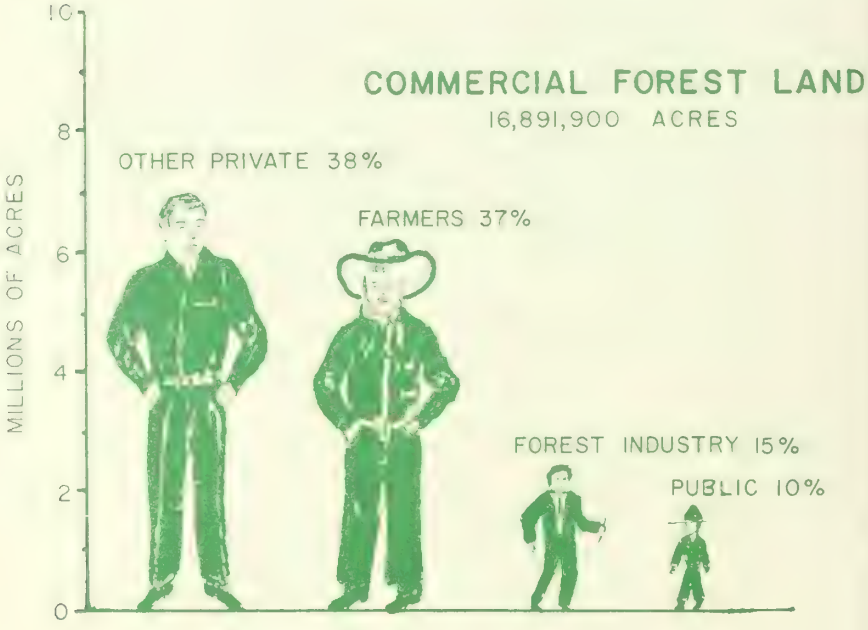

Figure 2. Commercial forest land ownership in Mississippi, 1967.

source: see table 2 in appendix

TIMBER

VOLUME of growing stock on commercial forest land reached a peak of 13.6 billion cubic feet in 1969. A slight drop was reported as of the beginning of 1970 due to heavy drain in 1969. There was an increased cut to furnish raw materials for new plywood and pulp mills, and there was hurricane Camille. The 1970 inventory of merchantable sized material consisted of slightly more than half pine, 51 percent. Pine sawtimber inventory exceeded hardwood sawtimber by 10.2 billion board feet.

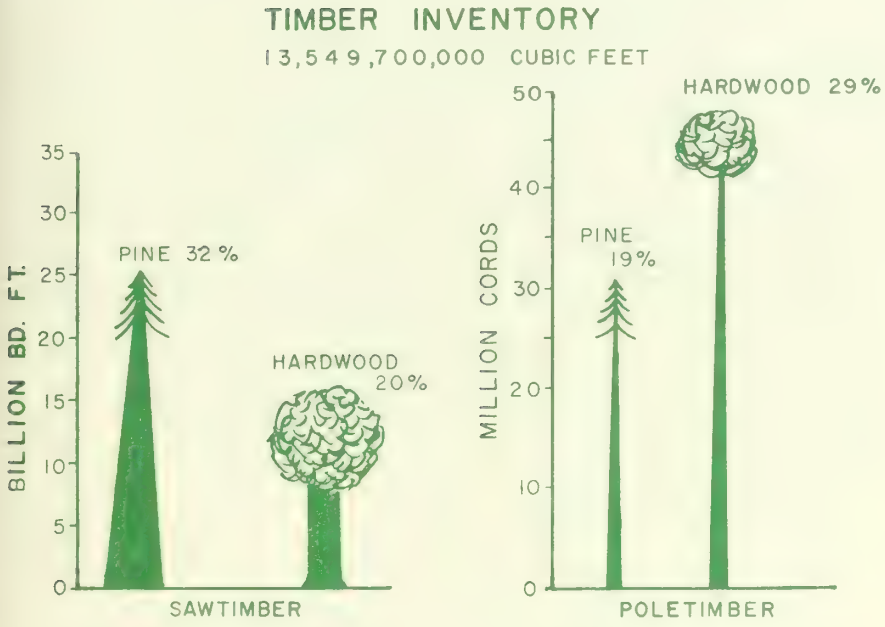

Figure 3. Timber inventory by species and size groups in Mississippi, 1970.

source: see table 3 in appendix.

EMPLOYMENT

EMPLOYMENT in timber based economic activities is at its highest point in over a decade.

The full time equivalent of people employed in growing and protecting the timber make up only the base from which emerges the many employment opportunities in processing and handling timber products. In fact, we can say that for every full time job[1] in growing and protecting timber, there are 31 other full time jobs in processing and handling timber products.

[1]Thousands of farmers and other owners spend part of their time in management activities. All of this time has been reduced to an equivalent full time basis.

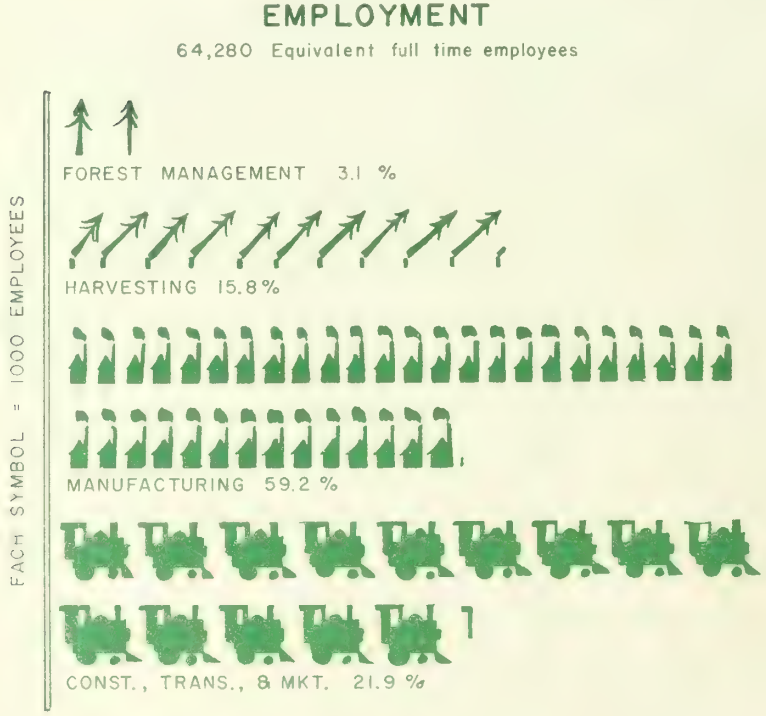

Figure 4. Estimated employment in timber-based economic activities in Mississippi, 1968.

source: see table 6 in appendix.

MANUFACTURING employment accounts for over one-half of all employment in timber-based activities with the lumber and wood products group employing 57 percent of the total. This group includes sawmills and planing mills, millwork, plywood, wooden containers, and a few miscellaneous plants. Paper and allied products, which includes pulp mills, paper mills, converted paper products, paperboard containers and boxes, building paper and hardboard mills, was next highest by employing nearly seven thousand people. Over fifty-six hundred people were employed in making wooden furniture and fixtures. Miscellaneous wood-based manufacturing plants employed almost four thousand people in producing wood-based products.

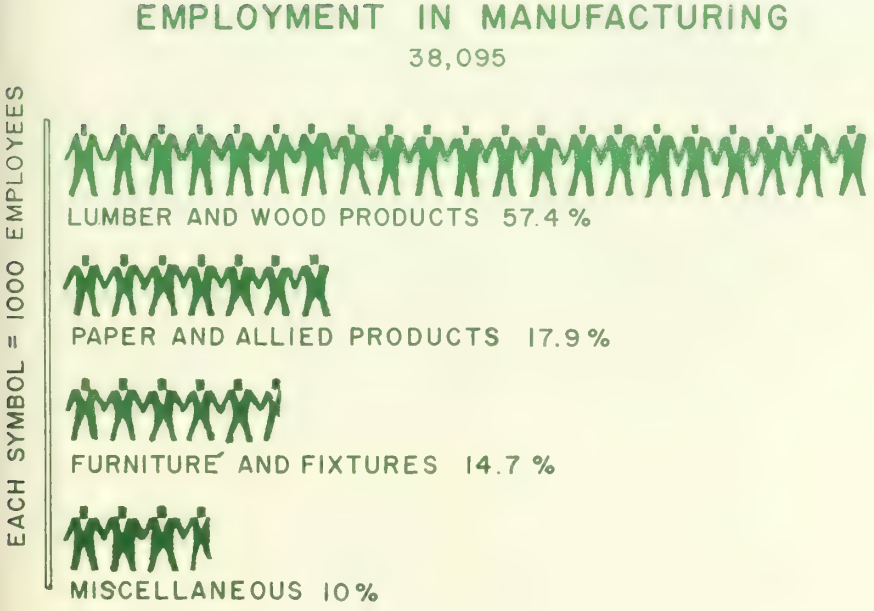
EMPLOYMENT IN MANUFACTURING
38,095
EACH SYMBOL = 1000 EMPLOYEES
LUMBER AND WOOD PRODUCTS 57.4 %
PAPER AND ALLIED PRODUCTS 17.9 %
FURNITURE AND FIXTURES 14.7 %
MISCELLANEOUS 10 %

Figure 5. Estimated employment in timber-based manufacturing industries in Mississippi, 1968.

source: see table 6 in appendix.

PAYROLLS

WAGES AND SALARIES earned in timber-based economic activity were dominated by the manufacturing sector which accounted for over 62 percent of the total.

It is estimated that for each 100 cubic feet of timber harvested in 1968 that $2.71 were earned in salaries and wages in the forest management sector, $8.80 in the harvesting sector, $46.08 in the manufacturing sector, and $16.11 in construction, transportation, and marketing.

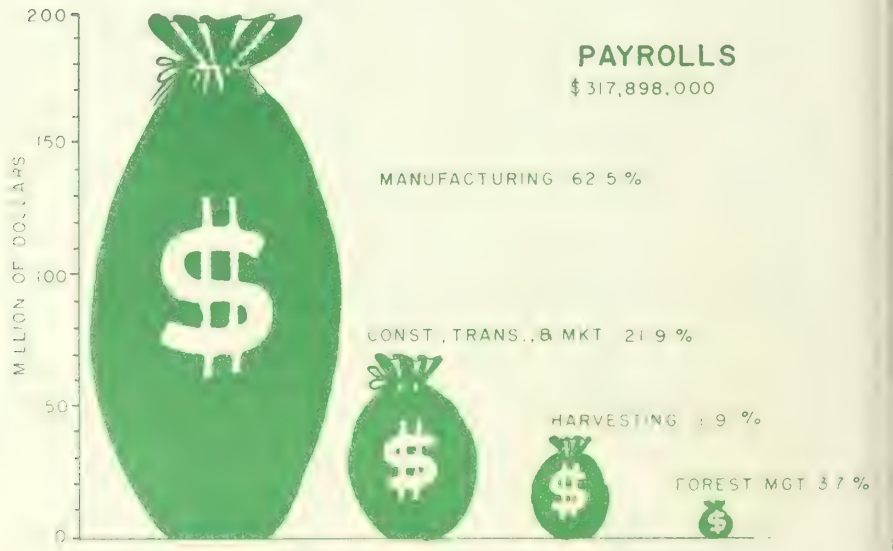

Figure 6. Estimated payrolls in timber-based economic activities in Mississippi, 1968.

Source: See table 6 in appendix.

MANUFACTURING payrolls in timber-based plants continue to increase, up 59 percent in the five years prior to 1968. The lumber and wood products group provided 50.7 percent of the total during 1968. Paper and allied products was the next highest group with 26.3 percent, while furniture and fixtures plants (wooden products) paid out 13.2 percent of the total. The remaining 9.8 percent came from miscellaneous wood-based plants.

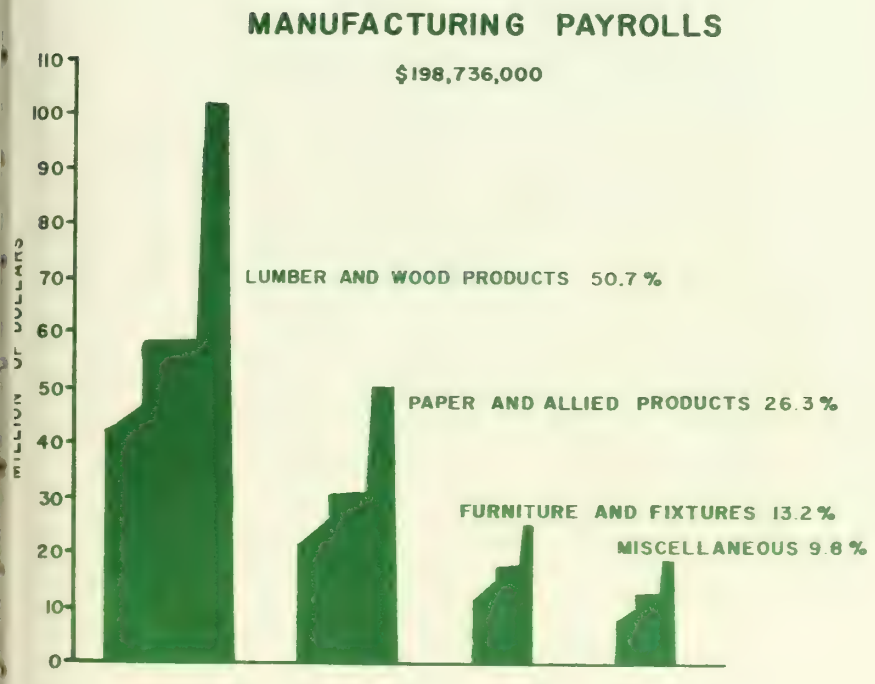

Figure 7. Estimated payrolls in timber-based manufacturing industries in Mississippi, 1968.

source: see table 6 in appendix.

VALUE ADDED

VALUE ADDED in timber-based economic activities was well over one-half billion dollars in 1968. This is more than double the 1958 figure. And here again the manufacturing sector dominates the picture, since over 60 percent of total value added occurred in this sector.

Conceptually, value added is the difference between the cost of goods purchased by an enterprise and the value of the products it sells. It is roughly equivalent to the amount of income earned or originating in that activity and represents that activity's contribution to gross national product.

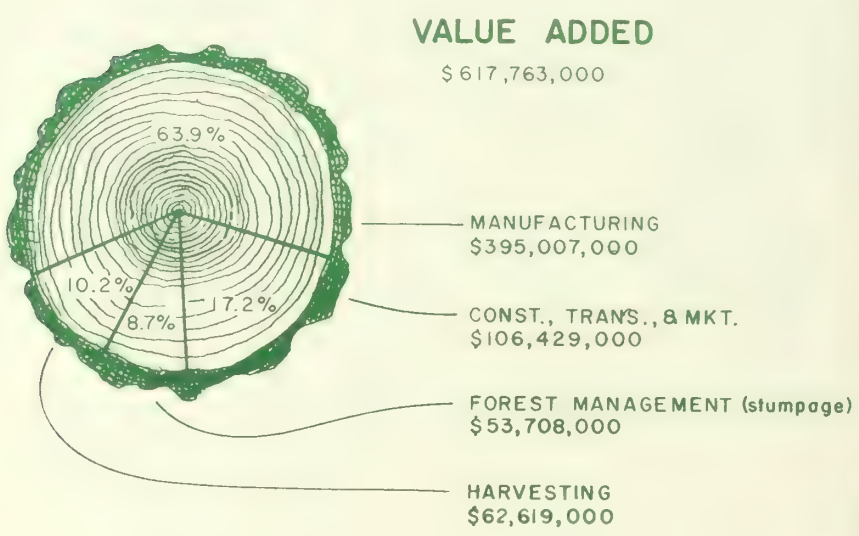

Figure 8. Estimated value added in timber-based economic activities in Mississippi, 1968.

source: see table 6 in appendix

It is estimated that for each 100 cubic feet of timber harvested in 1968, $12.45 of value added originated in forest management activities, $14.52 in harvesting, $91.57 in manufacturing, and $24.67 in construction, transportation, and marketing. Total value added for each 100 cubic feet of timber harvested was $143.21.

This is not to infer that the raw material, timber, is the only resource utilized in activities resulting in the value added. Plant, machinery, labor and money capital were also involved. It might also be pointed out that the value added was the result of growing, processing and handling timber and timber products with the technology and within the industrial structure existing in 1968. Any changes in these would of course affect value added.

It is also estimated that for each one dollar's worth of stumpage cut an additional $1.17 of value added originated in harvesting, $7.35 in manufacturing, and $1.98 in construction, transportation, and marketing. Total value added per $1.00 of stumpage cut was $11.50.

TIMBER-BASED manufacturing plants made up 36 percent of all manufacturing plants in 1968. Of the total value added in these timber-based plants, over one-half, or 50.4 percent, was in the lumber and wood products group. Within this group 38 percent was in sawmills and planing mills while approximately 13 percent was in plywood plants. The paper and allied products group added almost 100 million dollars or one-fourth of total value added in timber-based plants. Furniture and fixtures (wooden products) contributed 12 percent of the total while miscellaneous plants added 12.5 percent.

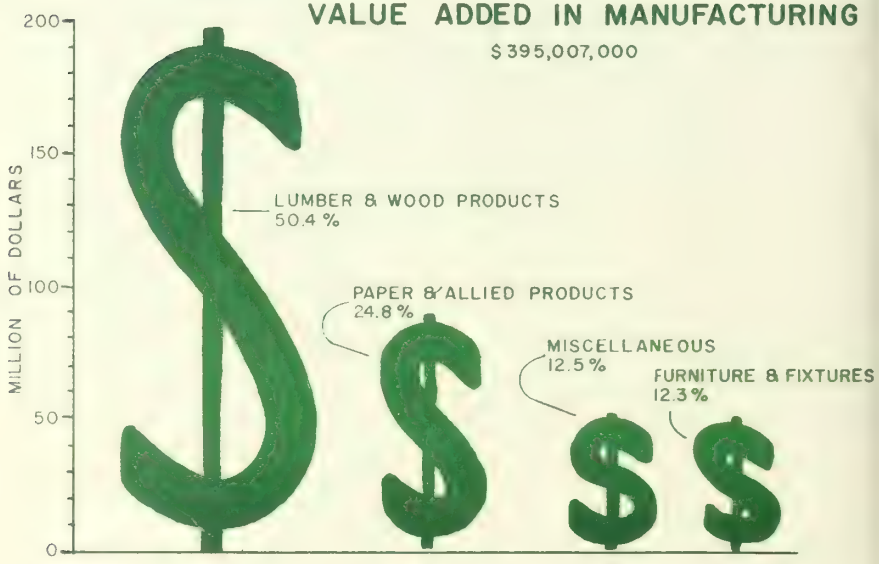

Figure 9. Estimated value added in timber-based manufacturing industries in Mississippi, 1968.

source: see table 6 in appendix

VALUE OF SHIPMENTS

SALE VALUE of timber and timber products as the stump and on through various stages of manufacturing and marketing is presented in the following tabulation. Some of the timber is consumed in the round form without much alteration for fence posts, poles, etc., while some is processed through many stages of manufacturing before it reaches the final consumer. The values presented here are for timber products either consumed in Mississippi or their value at the time they were shipped out of state. A large part of Mississippi's timber leaves the state before it moves very far up the processing chain and is processed into finished consumer products out of state.

It is estimated that in 1968 other states benefited by value added through further processing of timber after it left Mississippi in the amount of $714 million as compared to value added in Mississippi of $618 million.

Table 1. Value of shipments of timber products at various stages of processing in Mississippi, 1968.

Item	Value of Shipments
	Dollars
Stumpage	53,708,000
Raw products at local points of delivery	123,461,000
Lumber and wood products (primary manuf.)	392,481,000
Wood furniture and cabinets	99,992,000
Paper and allied products	207,724,000
Miscellaneous wood, wood based plastics and synthetics	89,600,000
Wood in construction	154,900,000
Transportation of wood products	19,400,000

SUMMARY

IN summation, timber-based economic activities are of major importance to the state of Mississippi. By all of the commonly used economic measures, it is clear that Mississippi's economy depends heavily on timber and timber-based activities. With commercial forest land occupying 56 percent of the total land area, one and one-half times that devoted to crop-land and pasture, it provides a firm base on which to grow raw material for continued expansion of the forest industry. Forest-based industry in 1968 operated 36 percent of all manufacturing plants, furnished 28 percent of all manufacturing employment, accounted for 26 percent of all manufacturing payrolls, and claimed 23 percent of all value added in manufacturing.

Timber-based economic activities alone, not counting substantial forest values in recreation, wildlife, grazing, aesthetics, and water, provided 64,280 full time jobs, a 318 million dollar annual payroll, gave rise to 618 million dollars income, and generated an estimated 1.6 billion dollars[1] in total spending in Mississippi during 1968.

[1] Based on what is considered to be a conservative multiplier of 2.55. There has been no applicable multiplier developed for Mississippi. This figure was assumed after review of national, regional, and local studies, and after consultation with Dr. Guy Peden, Director of Business Research, Mississippi State University.

APPENDIX

Value added as used here is reported by the Bureau of the Census and is an economic measure designed to avoid double counting in adding up the value of goods and services produced in the economy. Conceptually, it is the difference between the value of goods produced by an enterprise and the cost of goods purchased by it. It represents the money available to pay wages and salaries, interest, profits, direct taxes, and depreciation and depletion charges.

In this report all value added in forest management, harvesting, lumber and wood products, paper and allied products, and in wood and gum chemicals, was assigned to timber. Value added in furniture and fixtures, man-made fibers, and plastic materials and synthetics was reduced to allow for the use of non-wood materials. See the footnotes following appendix table 6 for details.

Employment, payrolls, and **value of shipments** in the various activities were assigned to timber also as indicated in the paragraph above.

The estimates shown in this report are not of equal reliability. Value added and value of shipments in manufacturing, construction, transportation, and marketing have been up-dated from Bureau of Census figures in most cases from 1966 to 1968. It should also be noted that figures for construction, transportation, and marketing were derived by less precise methods than the others. Even so, it is believed that the report can be very useful if these limitations are recognized. This is the best we have.

Table 2. Land, landownership, and timber inventory, Mississippi, 1966.

Land Class	Area	Growing Stock Volume[1/]	
		Softwood	Hardwood
	Thousand Acres	---- Million cubic feet ----	
Commercial Forest[2/]	16,891.9	6,554.8	6,479.8
Public	1,770.2	1,319.7	656.7
Forest Industry	2,505.1	1,252.3	914.4
Farmer	6,204.6	3,982.8	4,908.7
Other Private	6,412.0		
Cropland	6,565.3	---	---
Pasture and Range	3,716.9	---	---
Other	3,116.7	---	---
ALL LAND	30,290.8		

1/ Live trees of commercial species, 5.0 inches d.b.h. to a 4.0 inch top diameter outside bark.

2/ Forest land that is producing or is capable of producing crops of industrial wood and not withdrawn from timber utilization.

source: U.S.D.A. Forest Service, Resource Bul. SO-17, 1969. Standard tables 1 12, 13.

Table 3. Pine and hardwood inventory on commercial forest land in Mississippi, 1967-70.

Date	Growing Stock			Sawtimber		
	Total	Pine	Hardwood	Total	Pine	Hardwood
	Million cubic feet			Million board feet		
1967	13,034.6	6,384.9	6,479.8	41,427.4	24,628.8	16,798.6
1968	13,353.5	6,812.4	6,541.1	42,989.3	26,268.6	16,720.7
1969	13,632.9	7,018.0	6,614.9	43,650.1	26,954.6	16,695.5
1970	13,549.7	6,956.5	6,593.2	42,845.5	26,528.1	16,317.4

source: Adapted from Bulletins SO-15 and SO-23, U.S.D.A. Southern Forest Expt. Sta., N.O., La.

Table 4. Timber removal from commercial forest land in Mississippi, 1966.

Class	Sawtimber	Poletimber
	Million bd. ft.	Thousand cords
Softwood	1,005.7	1,056
Hardwood	956.4	1,599

source: computed from standard tables 17, 18, 23, U.S.D.A. Forest Service, Resource Bul. SO-17, 1969.

Table 5. Value added in timber-based economic activity in Mississippi, 1954, 1958, 1968.

Item	1968[1]	1958[2]	1954[3]
	$	$	$
Forest Management (stumpage)	53,708,000	23,300,000	33,150,000
Harvesting	62,619,000	42,850,000	64,450,000
Manufacturing	395,007,000	116,550,000	175,050,000
Construction	53,355,000	38,000,000	24,200,000
Transportation	13,561,000	9,000,000	8,000,000
Marketing	39,513,000	19,000,000	16,000,000
Total	617,763,000	300,700,000	320,850,000

[1] See appendix table 5.

[2] From Hair, Dwight. 1963. The Economic Importance of Timber in the U.S., U.S.D.A. Misc. Pub. No. 941.

Table 6. Summary table - Economic importance of timber to Mississippi, estimated, 1968.

Item	Employment	Payrolls	Value Added	Value of Shipments
	#	$	$	$
For. Management	1,277[1]	11,695,000[8]	53,708,000[17]	53,708,000[26]
Harvesting	10,738[2]	37,958,000[10]	62,619,000[18]	123,461,000[27]
Additional Manufacturing				
Lbr. & Wood Pr.	21,854[3]	100,681,000[11]	199,065,000[19]	392,481,000[28]
Furn. & Fix.	5,618[4]	26,300,000[12]	48,550,000[20]	99,992,000[29]
Paper & Allied	6,814[3]	52,271,000[11]	98,060,000[21]	207,724,000[30]
Misc.	3,809[5]	19,484,000[13]	49,332,000[22]	89,602,000[31]
Sub-total	38,095	198,736,000	395,007,000	789,799,000
Const.	6,056[6]	34,280,000[14]	53,355,000[23]	154,880,000[32]
Transp.	1,929[7]	13,268,000[15]	13,561,000[24]	19,353,000[33]
Mkt.	6,032[8]	21,961,000[16]	39,513,000[25]	77,841,000[34]
Sub-total	14,071	69,509,000	106,429,000	252,074,000
State Total	64,281	317,898,000	617,763,000	----------

Footnotes for this table on pages 24, 25, and 26

1/ Estimated employment in forest management was computed from figures furnished by state and federal agencies, Miss. Directory of Foresters, 1968 Economic Analysis of the Pulp and Paper Industry in the South, published by Southern Forest Institute, and personal contacts.

2/ Estimated from pulpwood harvested based on productivity of 533 cords per man year. Based on information from 1968 Economic Analysis of the Pulp and Paper Industry in the South published by Southern Forest Institute, U.S.D.A. Misc. Pub. No. 941, July 1963, and the 1963 Census of Manufacturers. Estimated employment in harvesting sawtimber based on productivity of 294,800 board feet per man year, developed from U.S.D.A. Misc. Pub. No. 941, July 1963 and 1963 Census of Manufacturers, and updated to 1968. Turpentine gum harvesting based on 125 barrels of gum per man year.

3/ As reported by Mississippi Employment Security Commission annual report for 1968.

4/ Reduced from reported figure for 1968 by Mississippi Employment Security Commission, to only that number attributed to timber. Employment attributed to timber considered to be the same ratio as the ratio of value of timber products consumed to other products consumed in the manufacturing process. This ratio from 1963 Census of Manufacturers.

5/ From 1968 Mississippi Employment Security Commission, but reduced to employment attributed to timber by same method as in 4 above. Includes gum and wood chemicals, plastics materials and synthetics, and man-made textile fibers.

6/ Employment in construction from Mississippi Employment Security Commission 1968, and reduced to employment attributed to timber. This was computed to be 22 percent of the total. Based on information obtained from "Construction Review", Business and Defense Services Administration, Bureau of the Census, Census of Manufacturers, Census of Mineral Industries, and U.S.F.S. Misc. Pub. No. 941, July 1963.

7/ Employment in transportation from Mississippi Employment Security Commission in 1968, and adjusted for attributed to timber by "Transport Statistics in the U.S.", Interstate Commerce Commission for both rail and truck transportation, and for water transportation from "Waterborne Commerce in the U.S.", U. S. Corps of Engineers.

8/ Employment in marketing from Mississippi Employment Security Commission, 1968, and reduced to employment attributed to timber by ratio of timber products sales to total sales taken from U.S.D.A. Misc. Pub. No. 941, July 1963.

9/ Estimated payrolls in forest management activities computed from 1968 Economic Analysis of the Pulp and Paper Industry published by Southern Forest Institute, Atlanta, Ga., plus information furnished by State and Federal Agencies on employment and salary charts, and small ownerships workers based on the minimum wage.

10/ Computed from information in 1968 Economic Analysis of the Pulp and Paper Industry published by Southern Forest Institute, supplemented by Mississippi Employment Security Commission data and other information indicating about 75 percent of all worker in harvesting make the minimum wage.

11/ As reported by Mississippi Employment Security Commission annual report for 1968.

12/ Reduced from that reported by Mississippi Employment Security Commission in 1968 to that estimated to be attributed to timber by the same procedure as in footnote #4.

13/ Reduced from that reported by Mississippi Employment Security Commission 1968 to that estimated to be attributed to timber by the same procedure as in footnote #5.

14/ Reduced from that reported by Mississippi Employment Security Commission 1968 to that estimated to be attributed to timber, see footnote #6.

15/ Reduced from that reported by Mississippi Employment Security Commission 1968 to that estimated to be attributed to timber, see footnote #7.

16/ Reduced from that reported by Mississippi Employment Security Commission 1968 to that estimated to be attributed to timber, see footnote #8.

17/ Equivalent to stumpage value. Volume of stumpage severed from Timber Severance Tax Division, State Tax Commission, Jackson, Miss. Stumpage value per unit obtained from U.S.F.S., Atlanta, Ga., U.S.D.A. Misc. Pub. No. 1086, and local price information. Pine sawtimber $45.51, Hardwood sawtimber $25.22, Pine pulpwood $5.01, Hardwood pulpwood $3.00.

18/ Value added in harvesting timber products computed by the ratio of payrolls to value added which existed in the 1963 Census of Manufacturers for logging camps and logging contractors.

19/ Computed for 1968 by updating value added in lumber and wood products as reported in 1966 Annual Survey of Manufacturers, Bureau of the Census. A factor was computed, dollars in value added per dollar of payroll which held in the 1966 census data, and this was applied to the 1968 payroll data as reported by the Mississippi Employment Security Commission to obtain 1968 value added. See U. S. Dept. of Commerce, "U. S. Industrial Outlook,1968," Dec. 1967, Appendix B.

20/ Computed for 1968 by applying a factor, dollars in value added per dollar of payroll which held in the 1966 census data for industrial classification of furniture and fixtures, to our 1968 payroll data.

21/ Computed for 1968 by taking 1968 Mississippi Employment Security Commission figures on payrolls for paper and allied products and applying a factor, dollars in value added per dollar of payroll which held in the 1966 Annual Survey of Manufacturers Census data.

22/ Computed for 1968 by taking Mississippi Employment Security figures for payrolls, adjusted to that attributed to timber, and applying a factor, dollars in value added per dollar of payroll which held in the 1963 Census of Manufacturers. See footnote 5 for items included.

23/ Computed for 1968 by the following method: (1) Total value of construction in the U.S. from "Construction Review" published by Business and Defense Services Administration, (2) Value of construction in Mississippi was reported by Hair in U.S.D.A. Misc. Pub. #941 to be 0.8 percent of U.S. total. This was used to determine total for Miss., (3) Total value added computed by subtracting construction materials cost from construction material in mineral industries (Census of Mineral Industries) and value of shipments of manufactured construction materials, taken from Census of Manufacturers, (4) Then assigning 22 percent of the computed value added to timber.

24/ Value added attributed to timber in railroad transportation was computed for Mississippi by data from "Transport Statistics in the U.S." published by the Interstate Commerce Commission for railroad transportation. The ICC has reported that 14.8 percent of freight revenue in the South is from forest products and this was assumed to hold for Mississippi. For water transportation as published by the Corp of Engineers, "Waterborne Commerce in the U.S.", forest products revenue computed to be 3.4 percent.

25/ Value added attributed to timber was computed from a ratio of value added per employee which held in Hair's 1963 report. This was updated and applied to our employment attributed to timber in marketing for 1968.

26/ Value of shipments by forest managers and landowners considered to be equivalent to stumpage received.

27/ Value at local points of delivery considered to be value of shipments by loggers and harvesters. This value computed by adding harvesting costs to stumpage value by product. Harvesting cost obtained from U.S.F.S., Mississippi Extension Service personnel, Mississippi Forestry Commission, and contact with loggers and sawmill personnel.

28/ Computed for 1968 by updating value of shipments in lumber and wood products as reported in 1966 Annual Survey of Manufacturers, Bureau of Census. A factor, dollars in value of shipments per dollar of payroll which held in the 1966 Census data, and this was applied to 1968 payroll data as reported by the Mississippi Employment Security Commission to obtain 1968 value of shipments.

29/ Computed for 1968 by applying a factor, dollars of value of shipments per dollar of payroll which held in the 1966 Census data, to our 1968 payroll data.

30/ Computed for 1968 by applying a factor, dollars of value of shipments per dollar of payroll which held in the 1966 Census data, to the 1968 payroll data as reported by the Mississippi Employment Security Commission.

31/ Computed for 1968 by applying a factor, dollars of value of shipments per dollar of payroll which held in the 1966 Census data, to our 1968 payroll data.

32/ Value of shipments in construction computed by the procedure as that for value added as outlined in appendix note #23.

33/ Value of shipments considered to be revenue received for transportation of forest products. This computed by the procedure as outlined for value added in appendix note #24.

34/ Value of shipments considered to be value of timber products sold. The 1968 value was derived from Mississippi Employment Security Commission on employment in retail and wholesale trade, adjusted by a ratio of timber products sold to total products sold. This same ratio, taken from Hair's work and updated, was applied to value of shipments. Timber products considered to be 8 percent of retail sales and 3 percent of wholesale sales.

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The Influence Of Planting Date On Agronomic And Fiber Properties Of Cotton

By: R. R. Bridge
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Conclusion

These data indicate that the highest yields were obtained from the April 17-21 planting. The lack of a variety x date interaction indicates that variety selection would not be influenced by planting date. The presence of a year x planting date interaction for fiber properties indicated that environment in any particular year was more important than planting date.

The Influence Of Planting Date On Agronomic And Fiber Properties Of Cotton

R. R. BRIDGE, W. R. MEREDITH, JR., and J. F. CHISM[1]

The influence of planting date on agronomic and fiber properties of cotton was measured by planting six varieties on three planting dates in 1968 and 1969.

Planting dates were April 17, May 2, and May 22 in 1968 and April 21, May 1, and May 20 in 1969. The varieties included in the study were; Stoneville 213, Deltapine 16, Stoneville 508, Coker 413-68, Hopicala, and Pee Dee 2165. Seed of these varieties were increased at Iguala, Mexico, to obtain approximately the same seed quality for each variety.

A split-plot design with eight replications was used each year. Main plots were planting dates and subplots were varieties. The plots consisted of two rows, 65 feet long with 40-inch spacing between rows. The seeding rate was approximately 15 pounds per acre of acid delinted seed planted in hills 15 inches apart. All seed received an in-furrow treatment of Terraclor Super X granules and Di-Syston applied at the rate of 5.4 lbs. per acre.

Data were obtained for each character from a sample taken directly from the cotton picker in each of the eight replications. Data were obtained on lint yield, lint percentage, seed index, seed germination, fiber length (2.5 percent and 50 percent length), fiber strength (g per tex), fiber elongation, and fiber fineness (micronaire) for both first and second harvest. Fiber property evaluations were made by the U.S. Cotton Fiber Laboratory of the Plant Science Research Division, Agricultural Research Service, U.S. Department of Agriculture, Knoxville, Tennessee.

Data are presented in 15 tables where Tables 1, 2, 7, 8, and 9 present 1968 results; Tables 3, 4, 10, 11, and 12 present 1969 results; and Tables 5, 6, 13, 14, and 15 present combined (1968-69) results.

Results and Discussion

Yield: The 2-year average (1968-69) shows lint yields to be significantly higher on the April planting date and to decrease with each later planting. The data indicate that the April 17-21 planting was 6 percent and 21 percent higher in yield than the May 1-2 and May 20-22 plantings, respectively.

These data also show that harvesting was completed much sooner for the early planting. Harvesting was completed by October 20, October 28, and November 19 for the April 17-21, May 1-2, and May 20-22 plantings, respectively. The 2-year average (1968-69) of all planting dates showed Stoneville 213 and Deltapine 16 to be the highest yielding varieties. Stoneville 213 yielded significantly more lint than the other varieties tested in both 1968 and 1969. These data showed that there was no significant variety x date interaction for lint yield.

Ranney (2) obtained maximum stands, stand uniformity, and yield with May 1-5 plantings. He also showed that in April plantings, stand, stand uniformity and yield were significantly increased by the use of a planter-box fungicide treatment. In later plantings, after May 1, there was no significant increase from the use of supplemental fungicides. Ranney also stated that farm operations should be planned to permit planting on April 21 or as soon thereafter as possible. Planting should be done when there is a high

---

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[2]RANNEY, C. D. 1968. Studies on planting dates of cotton on effect of three chemical treatments. Miss. Agr. Exp. Sta. Bull. 761. 20 p.

probability of having a 68°F soil temperature for a 10-day period following planting.

Lint Percentage: Planting date had no consistent effect on lint percentage. In 1968, the May 2 planting had a significantly lower lint percentage and in 1969 the April 21 planting was significantly lower. In most cases lint percentage was higher on the second harvest. This is probably due to the fact that the seed of the second harvest were smaller and more immature. The different weather conditions associated with the harvesting dates probably accounted for most of the interactions associated with lint percentage.

Seed Index and Seed Germination: Planting date had very little effect on seed index. In 1968, seed of the April 17 planting were significantly smaller than the other plantings. In 1969, there was no significant difference in seed index for the first harvest. Seed from the second harest were smaller than those from the st harvest for all plantings.

There was very little difference in ed germination for first harvest in 1968 nd 1969. In 1968, seed from May 22 plan ng had significantly better germination an the April 17 and May 2 first harvest s d. Seed from the second harvest was ne ly always lower in germination than t se obtained at first harvest. Generally, se from the second harvest should not be ed for planting. Seed quality of first har st seed will probably be associated more th existing environmental conditions an with planting dates.

Fiber Properties: Planting date ha no consistent effect on fiber properties. he presence of a year x planting te interaction for all fiber proper es indicated that environment in ny particular year was more important an planting date.

Mississippi. 1968.

	Date-Variety	Lint per acre Total	Lint per acre First pick	Lint per acre Percent first pick	Lint percent First pick	Lint percent Second pick	Seed index First pick	Seed index Second pick	Seed germination First pick	Seed germination Second pick
	Stoneville 213	1256	1143	91	38.5	37.8	10.2	8.0	85	77
	Deltapine 16	1191	1043	88	37.5	37.6	10.1	8.1	86	81
A	Stoneville 508	1105	965	87	36.8	36.4	10.6	9.0	86	75
	Coker 413-68	1071	941	88	36.8	36.6	10.1	8.4	88	78
	Hopicala	1006	802	80	39.0	38.1	11.3	9.6	87	74
	Pee Dee 2165	972	826	85	38.4	37.8	11.7	9.3	84	74
	Average	1100 a	953 a	87 a	37.8 a	37.4 a	10.6 b	8.7 b	86 b	76 c
	Stoneville 213	1260	1087	86	36.5	37.9	10.4	9.0	87	86
	Deltapine 16	1138	953	84	35.7	37.7	10.1	8.9	85	89
B	Stoneville 508	1039	847	81	34.0	36.4	11.0	10.0	90	87
	Coker 413-68	1016	853	84	34.5	36.1	10.0	9.0	88	87
	Hopicala	951	674	71	34.5	38.7	12.5	11.2	86	85
	Pee Dee 2165	947	726	77	35.3	38.0	12.2	11.4	82	90
	Average	1058 a	856 b	81 b	35.1 b	37.5 a	11.0 a	9.9 a	86 b	86 b
	Stoneville 213	1135	1020	90	38.0	36.5	10.3	9.2	93	81
	Deltapine 16	1076	979	91	37.5	35.7	9.5	8.7	93	83
C	Stoneville 508	943	832	88	35.0	34.7	11.2	10.0	92	85
	Coker 413-68	890	761	85	36.4	34.9	10.2	9.3	92	82
	Hopicala	904	671	74	38.8	36.5	12.7	11.5	90	80
	Pee Dee 2165	860	752	87	38.7	36.5	12.1	11.2	92	82
	Average	968 b	836 b	86 a	37.4 a	35.8 b	11.0 a	10.0 a	92 a	82 b

A - Planted April 17 - Defoliated Sept. 10 - Harvested Sept. 25 and Oct. 18, 1968.
B - Planted May 2 - Defoliated Sept. 26 - Harvested Oct. 9 and Oct. 28, 1968.
C - Planted May 22 - Defoliated Oct. 16 - Harvested Oct. 28 and Nov. 19, 1968.

Table 2: Influence of Planting Date on Fiber Length, Strength, Elongation, and Fineness. Stoneville, Mississippi. 1968.

		2.5% Span length		50% Span length		Fiber strength T1		Fiber elongation		Micronaire	
	Date-Variety	First pick	Second pick	First pick	Second pick	First pick	Second pick	First pick	Second pick	First pick	Second pick
	Stoneville 213	1.12	1.12	.53	.50	17.85	18.92	6.97	8.54	4.37	3.56
	Deltapine 16	1.15	1.14	.54	.51	18.94	19.50	8.18	9.73	3.98	3.40
A	Stoneville 508	1.18	1.22	.55	.53	18.90	20.29	7.41	8.83	3.67	3.00
	Coker 413-68	1.17	1.17	.54	.52	19.25	20.41	6.40	7.17	3.72	3.18
	Hopicala	1.10	1.15	.56	.55	22.30	23.65	6.32	7.38	4.06	3.26
	Pee Dee 2165	1.15	1.18	.54	.54	20.91	23.54	5.50	6.74	4.15	3.42
	Average	1.14 a	1.16 b	.54 a	.53 b	19.69 a	21.03 a	6.80 c	8.06 a	3.99 b	3.30 b
	Stoneville 213	1.10	1.09	.53	.49	17.74	17.00	7.73	8.18	4.34	3.87
	Deltapine 16	1.12	1.13	.53	.51	18.62	17.88	8.92	9.53	4.13	3.80
B	Stoneville 508	1.14	1.18	.55	.52	19.21	17.58	7.75	8.55	3.85	3.24
	Coker 413-68	1.14	1.15	.54	.50	18.33	16.33	6.56	7.30	3.91	3.53
	Hopicala	1.11	1.10	.57	.56	21.10	21.62	6.77	7.49	4.35	3.85
	Pee Dee 2165	1.14	1.16	.55	.54	21.25	21.54	5.78	6.42	4.42	4.03
	Average	1.14 a	1.14 c	.54 a	.51 c	19.82 a	19.04 c	7.31 b	7.83 b	4.18 a	3.72 a
	Stoneville 213	1.10	1.13	.51	.53	17.69	17.83	8.26	8.29	4.35	3.85
	Deltapine 16	1.14	1.18	.54	.54	18.28	18.19	9.46	9.09	4.09	3.43
C	Stoneville 508	1.21	1.23	.55	.56	18.74	19.27	8.51	8.50	3.56	3.26
	Coker 413-68	1.14	1.10	.55	.56	19.83	18.77	7.25	7.47	3.88	3.55
	Hopicala	1.15	1.19	.56	.60	21.70	22.13	7.20	6.91	4.44	3.84
	Pee Dee 2165	1.14	1.20	.55	.56	21.47	21.37	6.28	6.30	4.42	3.79
	Average	1.15 a	1.19 a	.54 a	.56 a	19.45 a	19.60 b	7.83 a	7.73 b	4.12 a	3.62 a

A - Planted April 17 - Defoliated Sept. 10 - Harvested Sept. 25 and Oct. 18, 1968.

C - Planted May 22 - Defoliated Oct. 16 - Harvested Oct. 28 and Nov. 19, 1968.

	Date-Variety	Lint per acre Total	First pick	Percent First pick	Lint per cent First pick	Second pick	Seed index First pick	Second pick	Seed germination First pick	Second pick
	Stoneville 213	950	800	87	36.7	38.8	10.4	9.5	93	91
	Deltapine 16	800	710	85	34.8	39.6	10.0	8.2	92	92
A	Stoneville 508	789	672	85	34.1	37.4	11.0	10.0	84	77
	Coker 413-68	686	532	64	31.6	36.8	11.2	9.5	94	93
	Hopicala	665	446	65	32.8	37.5	11.5	10.5	92	87
	Pee Dee 2165	726	587	81	34.4	38.1	10.9	10.0	94	90
	Average	776 a	635 a	81	34.5 b	38.1 b	11.1 a	9.9 a	91	88
	Stoneville 213	849	801	94	37.4	38.8	10.1	9.7	95	83
	Deltapine 16	806	709	87	36.1	37.7	10.0	9.5	96	74
B	Stoneville 508	727	605	84	35.2	36.4	10.4	10.3	85	93
	Coker 413-68	583	569	97	34.9	38.3	10.2	9.7	92	78
	Hopicala	644	438	68	33.5	39.0	11.7	11.0	96	66
	Pee Dee 2165	665	542	81	37.5	38.3	11.8	10.6	95	76
	Average	717 b	607 b	85	35.8 a	38.1 b	10.9 a	10.1 a	93	74
	Stoneville 213	724	573	79	38.5	40.0	10.3	9.0	93	79
	Deltapine 16	723	572	79	38.3	41.0	10.1	8.3	95	68
C	Stoneville 508	613	394	64	36.6	38.8	11.2	9.7	91	79
	Coker 413-68	457	269	59	36.0	40.5	10.9	8.3	94	81
	Hopicala	452	171	38	34.0	41.0	12.0	10.3	89	72
	Pee Dee 2165	514	376	73	37.3	39.9	11.6	9.7	94	69
	Average	580 c	392 c	67	37.6 a	40.2 a	11.0 a	9.2 b	92	75

A Planted April 21 Defoliated Sept. 12 Harvested Sept. 22 and Oct. 20, 1969.
B Planted May 1 Defoliated Sept. 25 Harvested Oct. 2 and Oct. 23, 1969.
C Planted May 20 Defoliated None Harvested Oct. 20 and Nov. 14, 1969.

Table 4: Influence of Planting Date on Fiber Length, Strength, Elongation, and Fineness. Stoneville, Mississippi. 1969.

		2.5% Span length		50% Span length		Fiber strength T1		Fiber elongation		Micronaire	
	Date-Variety	First pick	Second pick	First pick	Second pick	First pick	Second pick	First pick	Second pick	First pick	Second pick
	Stoneville 213	1.13	1.09	.53	.51	18.65	18.14	7.91	7.65	4.18	4.53
	Deltapine 16	1.16	1.09	.53	.50	19.37	18.48	8.97	8.61	3.96	4.34
A	Stoneville 508	1.17	1.14	.52	.51	19.25	18.99	8.77	8.30	3.26	3.67
	Coker 413-68	1.16	1.14	.52	.53	20.00	18.63	6.73	7.06	3.54	3.97
	Hopicala	1.08	1.09	.54	.54	23.10	23.20	6.83	7.23	4.23	4.13
	Pee Dee 2165	1.14	1.15	.54	.55	21.83	22.39	5.88	6.07	4.18	4.31
	Average	1.14 a	1.11 b	.53 b	.52 b	20.37 a	19.97 b	7.51 a	7.50 b	3.89 c	4.16 a
	Stoneville 213	1.08	1.11	.49	.50	17.92	17.99	7.39	8.14	4.50	4.20
	Deltapine 16	1.11	1.13	.49	.50	18.78	17.92	8.57	8.96	4.30	4.04
B	Stoneville 508	1.14	1.17	.49	.50	19.15	18.85	7.52	8.15	3.65	3.50
	Coker 413-68	1.13	1.16	.50	.50	19.36	19.12	6.17	6.76	3.95	3.93
	Hopicala	1.06	1.10	.53	.54	22.96	22.24	6.72	7.15	4.56	4.13
	Pee Dee 2165	1.10	1.14	.52	.52	21.45	21.83	5.37	6.25	4.57	4.25
	Average	1.10 b	1.13 a	.50 c	.51 b	19.94 b	19.66 b	6.96 b	7.57 b	4.26 b	4.01 b
	Stoneville 213	1.08	1.12	.53	.53	18.61	18.81	7.38	8.33	5.03	3.92
	Deltapine 16	1.12	1.14	.55	.54	19.37	19.13	8.97	9.73	4.68	3.77
C	Stoneville 508	1.16	1.18	.56	.56	19.31	20.51	7.71	8.57	4.30	3.45
	Coker 413-68	1.15	1.15	.56	.53	20.51	19.32	6.41	7.63	4.45	3.40
	Hopicala	1.11	1.10	.56	.54	23.96	22.87	6.55	7.70	4.65	3.76
	Pee Dee 2165	1.13	1.16	.56	.55	22.63	22.36	5.69	7.08	4.67	3.63
	Average	1.12 a	1.14 a	.55 a	.54 a	20.73 a	20.50 a	7.12 b	8.17 a	4.63 a	3.65 c

A Planted April 21 Defoliated Sept. 12 Harvested Sept. 22 and Oct. 20, 1969.
B Planted May 20 Defoliated Sept. 25 Harvested Oct. 20 and Nov. 14, 1969.
C Planted May 20 Defoliated None Harvested Oct. 20 and Nov. 14, 1969.

Table 5: 2-Year Average (1968-69) Influence of Planting Date on Lint Yield, Lint Percent, Seed Index, and Seed Germination. Stoneville, Mississippi.

		Lint per acre			Lint percent		Seed index		Seed germination	
	Date-Variety	Total	First pick	Percent first pick	First pick	Second pick	First pick	Second pick	First pick	Second pick
	Stoneville 213	1103	956	89	36.5	38.3	10.3	8.8	89	84
	Deltapine 16	1041	901	86	35.9	38.6	10.1	8.7	89	86
A	Stoneville 508	947	818	86	35.0	36.9	10.6	9.5	85	76
	Coker 413-68	821	736	89	34.2	36.7	10.6	9.0	91	85
	Hopicala	868	617	71	38.4	37.9	11.4	10.2	89	80
	Pee Dee 2165	849	706	83	37.0	38.0	11.9	9.9	89	82
	Average	938 a	794	84	36.2	37.7	10.9	9.3	88	82
	Stoneville 213	1079	944	87	36.9	38.3	10.3	9.2	91	84
	Deltapine 16	972	829	85	35.9	37.7	10.0	9.2	90	84
B	Stoneville 508	880	726	82	34.6	36.4	11.0	10.2	87	75
	Coker 413-68	767	696	90	34.7	37.2	10.2	9.3	90	82
	Hopicala	829	541	65	37.0	38.8	12.1	11.1	91	75
	Pee Dee 2165	797	625	78	36.4	38.1	12.0	11.0	89	83
	Average	887 b	727	81	35.9	37.8	10.9	10.0	90	80
	Stoneville 213	929	796	86	38.2	38.2	10.3	9.1	93	80
	Deltapine 16	900	775	86	37.9	38.3	9.8	8.5	94	75
C	Stoneville 508	778	613	79	35.9	36.7	11.2	9.9	91	82
	Coker 413-68	680	515	76	36.2	37.6	10.5	8.8	93	81
	Hopicala	671	421	62	38.9	38.7	12.3	10.9	89	76
	Pee Dee 2165	687	564	82	38.0	38.2	11.9	10.4	93	75
	Average	774 c	614	79	37.5	38.0	11.0	9.6	92	78

A Planted April 17-21 Harvested Sept. 22-25 and Oct. 18-20.
B Planted May 1-2 Harvested Oct. 2-9 and Oct. 23-28.
C Planted May 20-22 Harvested Oct. 20-28 and Nov. 14-19.

Table 6: 2-Year Average (1968-69) Influence of Planting Date on Fiber Length, Strength, Elongation, and Fineness. Stoneville, Mississippi.

		Fiber length		Fiber length U		Fiber strength T1		Fiber elongation		Micronaire	
	Date-Variety	First pick	Second pick	First pick	Second pick	First pick	Second pick	First pick	Second pick	First pick	Second pick
	Stoneville 213	1.09	1.10	.51	.50	17.83	17.50	7.56	8.16	4.52	4.03
	Deltapine 16	1.11	1.12	.52	.51	18.80	17.90	8.74	9.25	4.26	3.92
B	Stoneville 509	1.17	1.18	.52	.51	19.18	18.37	7.65	8.36	3.65	3.37
	Coker 413-68	1.14	1.15	.52	.50	19.35	18.73	6.51	6.98	3.93	3.73
	Hopicala	1.18	1.17	.57	.55	22.76	21.92	6.74	7.22	4.45	4.00
	Pee Dee 2165	1.13	1.11	.53	.51	21.35	21.08	5.68	6.23	4.49	4.14
	Average	1.14	1.13	.53	.51	19.88	19.35	7.13	7.70	4.22	3.86
	Stoneville 213	1.08	1.07	.51	.50	18.15	18.31	7.82	8.30	4.69	3.88
	Deltapine 16	1.11	1.10	.53	.54	18.82	18.66	9.22	9.41	4.38	3.60
C	Stoneville 508	1.18	1.21	.55	.56	19.03	19.89	8.10	8.44	3.93	3.35
	Coker 413-68	1.16	1.17	.54	.54	19.77	19.94	6.83	7.35	4.16	3.47
	Hopicala	1.12	1.14	.56	.57	22.83	22.50	6.87	7.30	4.54	3.80
	Pee Dee 2165	1.13	1.15	.53	.55	22.05	21.47	5.48	6.09	4.55	3.71
	Average	1.13	1.16	.55	.58	20.11	20.05	7.47	7.95	4.38	3.64

A Planted April 17-21 Harvested Sept. 22-25 and Oct. 18-20.
B Planted May 1-2 Harvested Oct. 2-9 and Oct. 23-28.
C Planted May 20-22 Harvested Oct. 20-28 and Nov. 14-19.

Table 7: Average Variety Performance for Three Planting Dates, 1968

	Lint Yield					
	Lint		First Pick		Percent First Pick	
Stoneville 213	[illegible]	a	1083	a	89	a
Deltapine 16	1135	b	[illegible]		87	a
Stoneville [illegible]	[illegible]		881		86	ab
Coker 413-68	[illegible]	d	851	c	85	ab
Ipicala	[illegible]	e	715	e	75	c
De Dee 2165	[illegible]	e	718		83	b

	Lint Percent					
	First Pick				Second Pick	
Stoneville 213	37.7	a			37.4	a
Ipicala	37.4	a			37.	a
De Dee 2165	37.5	a			37.	a
Deltapine 16	36.9	ab			36.	b
Coker 413-68	36.9	b			35.9	c
Stoneville 508	35.3	c			35.8	c

	Seed Index					
Ipicala	12.2	a			10.	a
De Dee 2165	11.0	b			10.	a
Stoneville 508	11.0	b			9.	b
Stoneville 213	10.3	c			8.7	
Coker 413-68	10.1	c			8.	
Deltapine 16	9.9	c			8.	c

Table 8: Average Variety Performance for Three Planting Dates, 1968

	Seed Cotton Yield					
	First Pick				Second Pick	
Coker 413-68	89	a			83	a
Stoneville [illegible]	89	a			82	a
Stoneville [illegible]	88	a			82	a
Deltapine 16	88	a			84	a
[illegible]	88	a			80	a
[illegible]	86	a			81	a

	2.5% Span Length					
	First Pick				Second Pick	
Stoneville [illegible]	1.19	a			1.21	a
[illegible]	1.17	a			1.17	b
[illegible]	1.14	b			1.18	b
Deltapine 16	1.14	bc			1.15	c
[illegible]	1.11	c			1.14	c
Stoneville 213	1.11	c			1.11	d

	[illegible]					
[illegible]	.56	a			56	a
De Dee 2165	.55	a			54	a
[illegible]	.54	a			53	b
Coker 413-68	.53	a			53	bc
[illegible]	.53	a			52	c
Stoneville [illegible]	.52	c			52	c

Table 9: Average Variety Performance for Three Planting Dates. 1968.

	Fiber Elongation E_1	
	First Pick	Second Pick
Deltapine 16	8.85 a	9.45 a
Stoneville 508	7.90 b	8.57 b
Stoneville 213	7.65 c	8.38 b
Coker 413-68	6.84 d	7.28 c
Hopicala	6.76 d	7.19 c
Pee Dee 2165	5.86 e	6.42 d
	Fiber Strength (grams/tex)	
	First Pick	Second Pick
Hopicala	22.18 a	22.46 a
Pee Dee 2165	21.21 a	22.15 a
Coker 413-68	19.20 b	19.17 b
Stoneville 508	18.95 bc	19.15 b
Deltapine 16	18.68 bc	18.53 c
Stoneville 213	17.76 c	17.92 d
	Fiber Fineness (Micronaire)	
Stoneville 213	4.42 a	3.76 a
Pee Dee 2165	4.33 a	3.75 a
Hopicala	4.28 a	3.66 ab
Deltapine 16	4.10 b	3.54 bc
Coker 413-68	3.84 c	3.42 c
Stoneville 508	3.63 d	3.17 d

Table 10: Average Variety Performance for Three Planting Dates. 1969.

	Lint Yield Per Acre		
	Total	First Pick	Percent First Pi
Stoneville 213	856 a	733 a	85
Deltapine 16	806 b	678 b	84
Stoneville 508	707 c	556 c	78
Pee Dee 2165	628 d	495 d	79
Coker 413-68	558 e	446 d	80
Hopicala	586 e	336 e	57
	Lint Percentage		
	First Pick	Second Pick	
Hopicala	38.8 a	39.3 a	
Stoneville 213	36.8 b	39.2 a	
Pee Dee 2165	36.8 b	38.8 ab	
Deltapine 16	36.2 c	39.5 a	
Stoneville 508	35.1 d	37.6 b	
Coker 413-68	34.2 e	38.5 ab	
	Seed Index		
Pee Dee 2165	11.8 a	10.3 b	
Hopicala	11.7 a	10.7 a	
Stoneville 508	11.0 b	10.0 b	
Coker 413-68	10.8 b	9.2 c	
Stoneville 213	10.3 c	9.3 c	
Deltapine 16	10.0 c	9.0 c	

ble 11: Average Variety Performance for Three Planting Dates. 1969.

	Seed Germination	
	First Pick	Second Pick
ltapine 16	94	79
e Dee 2165	94	78
oneville 213	93	84
ker 413-68	93	84
picala	92	75
-165	94	78
	2.5% Span Length	
	First Pick	Second Pick
oneville 508	1.16 a	1.16 a
ker 413-68	1.15 ab	1.15 b
ltapine 16	1.13 ab	1.12 c
e Dee 2165	1.12 bc	1.15 ab
oneville 213	1.10 cd	1.11 cd
picala	1.08 d	1.10 d
	50% Span Length	
picala	.54	.54
e Dee 2165	.54	.54
ker 413-68	.53	.52
oneville 508	.53	.52
ltapine 16	.53	.51
oneville 213	.52	.51

Table 12: Average Variety Performance For Three Planting Dates. 1969.

	Fiber Elongation E_1	
	First Pick	Second Pick
Deltapine 16	8.84 a	9.12 a
Stoneville 508	8.00 b	8.34 b
Stoneville 213	7.56 c	8.04 b
Hopicala	6.70 d	7.36 c
Coker 413-68	6.43 d	7.15 c
Pee Dee 2165	5.64 e	6.47 d
	Fiber Strength (grams/	
	First Pick	Second Pick
Hopicala	23.34 a	22.77 a
Pee Dee 2165	21.97 b	22.19 a
Coker 413-68	19.96 c	19.02 b
Stoneville 508	19.24 d	19.45 b
Deltapine 16	19.17 d	18.51 c
Stoneville 213	18.39 e	18.31 c
	Fiber Fineness (Micronaire)	
Stoneville 213	4.57 a	4.22 a
Hopicala	4.48 ab	4.01 a
Pee Dee 2165	4.43 ab	4.06 a
Deltapine 16	4.31 b	4.05 a
Coker 413-68	3.98 c	3.77 b
Stoneville 508	3.73 c	3.54 c

Table 13: 2-Year Average (1968-69) of Six Varieties for Three Planting Dates.

	Lint Yield Per Acre		
	Total	First Pick	Percent First Pi
Stoneville 213	1037	909	86
Deltapine 16	971	835	86
Stoneville 508	868	719	83
Coker 413-68	789	649	82
Pee Dee 2165	778	632	81
Hopicala	756	526	69

	Lint Percentage	
	First Pick	Second Pick
Hopicala	38.1	38.5
Stoneville 213	37.2	38.3
Pee Dee 2165	37.1	38.1
Deltapine 16	36.6	38.2
Stoneville 508	35.2	36.7
Coker 413-68	35.0	37.2

	Seed Index	
Hopicala	12.0	10.7
Pee Dee 2165	11.9	10.4
Stoneville 508	11.0	9.8
Coker 413-68	10.5	9.0
Stoneville 213	10.3	9.0
Deltapine 16	10.0	8.8

Table 14: 2-Year Average (1968-69) of Six Varieties for Three Planting Dates.

	Seed Germination	
	First Pick	Second Pick
Stoneville 213	91	83
Deltapine 16	91	82
Coker 413-68	91	83
Pee Dee 2165	90	80
Hopicala	90	77
Stoneville 508	88	77

	2.5% Span Length	
	First Pick	Second Pick
Stoneville 508	1.18	1.19
Coker 413-68	1.16	1.16
Deltapine 16	1.13	1.14
Pee Dee 2165	1.13	1.18
Stoneville 213	1.10	1.11
Hopicala	1.10	1.12

	50 Span Length	
Hopicala	.55	.55
Pee Dee 2165	.54	.54
Stoneville 508	.54	.53
Coker 413-68	.54	.52
Deltapine 16	.53	.52
Stoneville 213	.52	.51

Table 15: 2-Year Average (1968-1969) of Six Varieties for Three Planting Dates.

	Fiber Elongation	
	First Pick	Second Pick
Deltapine 16	8.84	9.29
Stoneville 508	7.95	8.45
Stoneville 213	7.60	8.19
Hopicala	6.73	7.28
Coker 413-68	6.63	7.21
Pee Dee 2165	5.75	6.44
	Fiber Strength (grams/tex)	
	First Pick	Second Pick
Hopicala	22.76	22.61
Pee Dee 2165	21.59	22.17
Coker 413-68	19.58	19.10
Stoneville 508	19.09	19.30
Deltapine 16	18.93	18.52
Stoneville 213	18.07	18.11
	Fiber Fineness (Micronaire)	
Stoneville 213	4.49	3.99
Pee Dee 2165	4.40	3.90
Hopicala	4.38	3.83
Deltapine 16	4.20	3.79
Coker 413-68	3.91	3.59
Stoneville 508	3.68	3.35

ULLETIN 787 AUGUST 1971

NNUAL INCOME PAYMENTS:

An Approach to Increased Productive Efficiency in Small Forestland Resource Use

MISSISSIPPI STATE UNIVERSITY

AGRICULTURAL AND FORESTRY EXPERIMENT STATION

JAMES H. ANDERSON, Director

TATE COLLEGE MISSISSIPPI

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ANNUAL INCOME PAYMENTS: AN APPROACH TO INCREASED PRODUCTIVE EFFICIENCY IN SMALL FORESTLAND RESOURCE USE

by

John K. Hosemann and John E. Waldrop, Jr.*

The problem of inefficient resource use which characterizes small forestland tracts in the South has concerned economists, foresters, and forest industrial leaders for some time.[1/] Their concern is couched in the conviction that future timber supplies, if they are to meet future timber demands, must be produced on some 188 million acres in the Geographical South of which 107 million acres is privately owned.[2/] Average timber production on this acreage in 1962 was estimated to be only .47 cords per acre. This is contrasted with the estimate of .73 cords per acre on national forestlands in the same region.

Mississippi's small forest land ownerships are comparable to small forestlands throughout the South. That is, relative to forestlands held in other ownerships, they are of low productivity. Numerous research efforts have disclosed a variety of factors

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1/ Small forestland tracts are defined by the U.S.D.A., Forest Service as those forest land acres producing or capable of producing crops of industrial wood and not withdrawn from timber utilization by statue or administrative regulation and containing 5,000 acres or less. In this study small forests refer to tracts of less than 300 acres.

2/ The South's Third Forest, Report of the Southern Forest Resource Analysis Committee, 1969, p. 42.

related to the absence of intensive forestry management on small land ownerships.[3/]

The Yazoo-Little Tallahatchie Watershed Region which includes all or part of 19 northwest Mississippi counties (Figure 1), is typical of the South and Mississippi in terms of small land ownership patterns and owner characteristics.[4/]

The Yazoo-Little Tallahatchie Watershed Project[5/] was initiated as a soil erosion control and flood prevention project. The accomplishment of the goals of this project--(1) reduction of floodwater and sedimentation, (2) proper land use, (3) channel stabilization, and (4) improvement of the local economy--has been in progress since 1936.[6/] In pursuing the goals just presented, several cooperating public agencies found the planting of pine trees excellent in preventing soil erosion and rapid runoff. Since 1948 more than 500,000 acres of

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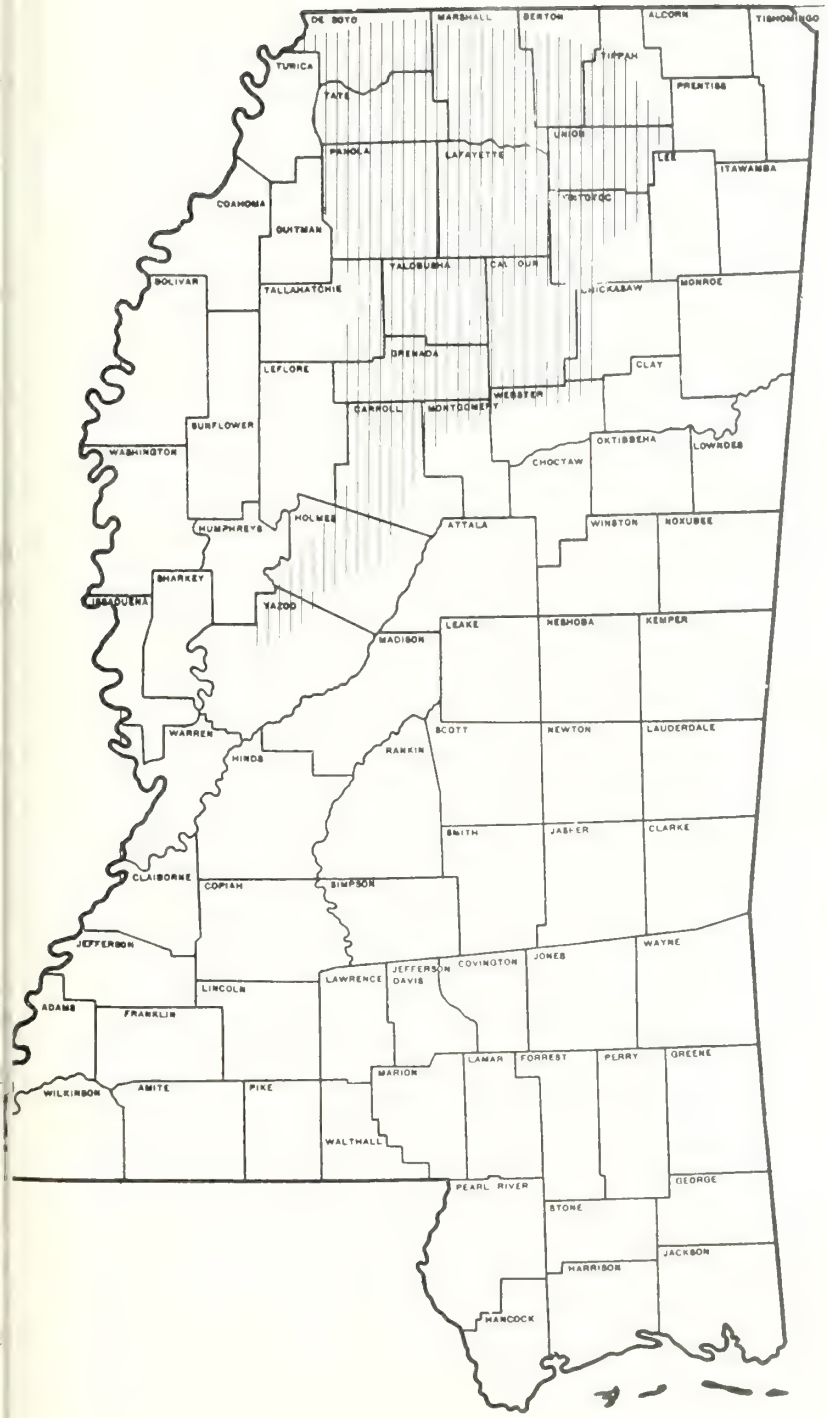
3/ Bertrand, Alvin L.; Hansbrough, Thomas; South, Donald R., Factors Related to the Adoption of Woodland Management Practices, Louisiana State University in cooperation with Southern Forest Experiment Station, Forest Service, U.S.D.A. Bulletin No. 603, Sept. 1965; Guttenberg, Sam; Perry, Joe D., Southwest Arkansas' Small Woodland Owners, Southern Forest Experiment Station, New Orleans, Louisiana, Occasional Paper 170, 1959; and Sollie, Carlton R., Factors Related to Use of Recommended Forestry Practices in Five Mississippi Counties, Mississippi State University, Agricultural Experiment Station Bulletin 753, December, 1967, and others.

4/ Appendix Table 1.

5/ The Yazoo-Little Tallahatchie Watershed Project has come to be known by professional foresters and landowners as the Y-LT. This abbreviation will be used throughout the study.

6/ Guttenberg, Sam and Alfred Pleasonton. Stimulating Woodland Management in North Mississippi: An Appraisal. Forest Service Occasional Paper 185. New Orleans, Louisiana. U.S. Department of Agriculture, Southern Forest Experiment Station, 1961.



gure 1. The Yazoo-Little Tallahatchie Watershed Project Area.

loblolly pine plantations have been established in the watershed. Most of these pine plantations are on lands that involve more than 9,000 owners, Appendix Table 1. Many acres of these privately held forests will be of merchantable size in the near future.

The Problem

The Y-LT Project leadership is concerned that those plantations established on small private ownerships, which account for a substantial part of a public expenditure in excess of 30 million dollars, may be liquidated as they reach merchantable size. The pessimism of project leadership regarding the clearcutting on small land ownerships is well founded. There are available markets for timber that did not exist in the past when most of the trees were planted. The characteristics of the landowners, as presented in Appendix Table 1, are likely associated with short planning horizons and high time preference rates due to the uncertainties of income (for them) 20 to 40 years in the future. That is, the landowners are older with low annual incomes and few asset holdings. These are characteristic of individuals who favor present rather than future consumption.[7/]

Landowners with the above characteristics may clearcut plantations as they reach merchantable size. Once this clearcutting has taken place, future land use will be at the discretion of the individual landowner.

7/ See: Bohm von Bawerk, Eugene, The Positive Theory of Capital trans. William Smart, M. A. (G. E. Stechert and Co., New York, New York, 1930) p. 275-277.

The goals of the Y-LT Watershed Project mentioned earlier are best summarized by the remedial conservation practices that have benefitted the lands downstream from the project region as well as those lands within the region. However, the question arises whether the goals of efficiency in timber production and conservation can be pursued simultaneously in this 19-county area. That is, on one hand, the landowners may liquidate timber stands soon after they become merchantable to obtain current income. On the other hand, the ground cover required to prevent erosion as well as management for efficient resource use may require delays in harvest cuts. The apparent conflict between the individual landowner and society regarding efficient resource use is brought into focus when the goals of society are left to the decisions of individual landowners.

The goals of the small forestland owners in general likely range from a profit maximization motive on through pleasure, recreation, ownership, security, and the like, although not necessarily in this order of preference. Many owners of small forest tracts may hold woodlots for a combination of these reasons.[8/]

For example, some of the alternatives facing individual landowners when trees reach a marketable size might include:

1. Clearcut trees and use the revenues for current consumption;
2. Clearcut trees and reinvest revenues in farm enterprises that yield more immediate revenues;

8/ McMahon, Robert O., Private Nonindustrial Ownership of Forestland, Yale University: School of Forestry, Bulletin No. 68, New Haven, Connecticut. 1964.

3. Clearcut and replant trees;

4. Manage trees for efficient timber production.

In contrast alternatives of society to preserve the watershed values could include:

1. Acquiring lands through condemnation;

2. Zoning lands for forestry;

3. Consolidating lands via taxation measures;

4. Permitting the watershed to return to its eroded state;

5. Initiating a new timber program on lands which are clear-cut, i.e., start the watershed program anew;

6. Paying landowners to leave their land in timber production in perpetuity;

7. Increasing annual profits to landowners from timber production.

This study was concerned with the last two alternatives of the landowners and of society. These alternatives involved the estimation of timber productivity on an annual basis and some proposal for annual productivity payments. The hypothesis underlying this investigation was that annual payments of the estimated timber productivity under intensive management would make timber production on these small forestland ownerships a realistic alternative land use, and thereby increase the productive efficiency of these resources.

The Y-LT Project was founded in a spirit of conservation. This study dealt exclusively with efficient resource use. Others who are more qualified must assess any proposals made as to whether each achieves the conservation goals.

Objectives

The general objective of this study was to evaluate an annual income payment scheme as to its potential for increasing the productive efficiency of small forestland ownerships in the Y-LT Watershed Region.

More specifically, this study was designed to: (1) estimate timber productivity by site index classification and value this productivity at specified rates of discount for specified costs and product prices, and (2) evaluate alternative schemes for providing owners of small forestland tracts with an annual income payment in accordance with the productivity of their timberland.

CONCEPTUAL PROBLEMS AND PROCEDURES

Conceptualizing the problems involved in investments in Forestry and developing the models necessary to obtain actual estimates of annual productivity estimates are somewhat technical in nature. For this reason a discussion of these activities has been placed in the Appendix.

PRODUCTIVITY OF PLANTED LOBLOLLY PINE TIMBER IN THE YAZOO-LITTLE TALLAHATCHIE WATERSHED

The analysis necessary to estimate the productivity of planted timber in the Y-LT Watershed required estimates of yields, prices ar costs, and the selection of discount rates. Two basic situations were considered. The analysis of these situations included: (A) t analysis of timberland free of timber and trash, and (B) the analys of land already planted to timber under the watershed program. Othe variations of these situations are discussed in a later section.

Yields

Yields used in the analysis were provided by personnel from the Y-LT Watershed Project. In 1959 the project authorities established 99 plots in Civilian Conservation Corps plantations of loblolly pine 18-24 years old.[9/] The plots were established on a wide variety of timberland sites and stand densities, with best sites given as site index 90 and poorest sites as site index 60.[10/] Per acre harvested

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9/ A total of 199 plots were established; 99 were loblolly pine, 88 shortleaf pine, and 12 slash pine.

10/ Site index or site class in the classification of forestla in terms of inherent capacity to grow crops of timber with the numer ical values assigned to a particular site class indicating the heigh in feet attained by the taller trees in an even-aged stand during 50 years' growth, e.g., site index 60 means that in 50 years the talle trees would reach a height of 60 feet.

lds were estimated when thinned back to 100 square feet basal a[11/] Appendix Tables 2-5. Actual yield data through 1967 and jections of yields to 40 years of age were used in this study.[12/] yields and projections were estimated by Y-LT Project personnel.

Prices

Prices used in this study were $6 per cord for pulpwood and $50 thousand board feet of sawtimber. It may be noted here that prices subject to change which would result in changes in productivity. ever, such changes can be analyzed whenever they occur.

Costs

Costs used in this analysis were those given by Y-LT Project sonnel. These costs are based on recent costs of planting timber the watershed. A $20-per-acre cost for open land planting and a 60-per-cord cost of marking trees for thinning were used in this

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11/ Basal area: the area in square feet of the cross section at ast height (usually 4½ feet) of a single tree or of all the trees a stand usually expressed as square feet of basal area per acre.

12/ Rotations longer than 40 years were not considered for two or reasons: (1) previous studies have shown that optimum rotations seldom longer than 40 years. See: Holmes, Mac Reese, An Economic alysis of Planted Timber Stands in Northwest Louisiana, (Unpublished sters Thesis, Department of Agricultural Economics, Louisiana State versity, Baton Rouge, Louisiana, January 1967); and Holmes, Mac Reese, Application of Quantitative Economic Analysis to Forest Management oblems, (Unpublished doctoral dissertation, Department of Agricultural nomics, Mississippi State University, State College, Mississippi, 1970); (2) Yields for rotations longer than 40 years were not ailable and projections for periods longer than 40 years would likely volve gross errors.

study. The $20-per-acre cost of openland planting is subject to change as site quality changes, i.e., higher costs on the better sites.

Discount Rates

Several rates of discount were used in this analysis. These rates were selected for reasons discussed in detail in a later secti The rates used were 4.125, 5.75, 7, 8, 10, and 18 percent.

Planted Timber Productivity Estimates

The economic productivity of timber can be estimated in several ways. One acceptable method for estimating the productivity of plan timber stands is to determine the optimum rotation length by selecti the largest capitalized value for a given discount rate and site cla Capitalized values or "values in perpetuity" are obtained by using Model (2) in the Appendix.13/

Table 1 contains optimum rotations and capitalized values for planted loblolly pine timber stands on four site classes and for five rates of discount.

At an 18 percent rate the optimum rotation for all site classes was 20 years. However, it should be noted that no site yielded positive returns of 18 percent. Capitalized values for the lowest rate ranged from $38.09 for site index 60 to $247.15 for site index 90 with the latter rotation sufficiently long to realize revenues from sawtimber harvests.

13/ Partial budgets for the undiscounted costs and returns from six planted loblolly pine timber enterprises are presented in Appendi Tables 7 through 12.

Table 1. Optimum rotations and capitalized values for planted loblolly pine timber stands in the Yazoo-Little Tallahatchie Watershed, for four site classes of timberland, by site index, for five rates of discount.

Discount rate	SITE INDEX 60 Rotation length	60 Capitalized value	70 Rotation length	70 Capitalized value	80 Rotation length	80 Capitalized value	90 Rotation length	90 Capitalized value
Percent	Years	Dollars	Years	Dollars	Years	Dollars	Years	Dollars
4.125	30	38.09	25	65.76	40	139.88	40	247.15
5.75	20	13.99	25	29.72	40	66.12	40	120.34
7	20	4.39	20	14.85	40	36.64	40	70.50
10	20	-7.78	20	-2.54	40	3.39	40	15.68
18	20	-17.34	20	-16.21	20	-15.05	20	-13.44

Source: Appendix Tables 13 through 32.

Situation A: Annual Productivity Estimates for Timber Planted on Land Free of Timber and Trash

Situation A assumes that timber must be established at a cost of $20 per acre and that the periodic cost as defined in this study are covered. Annual equivalent estimates for this situation are presented in Table 2.

As would be expected optimum rotation lengths and annual equivalent estimates varied by site quality and by discount rates. For a discount rate of 10 percent only site index 80 and 90 yielded positive returns. The estimates for a 4.125 percent rate of discoun ranged from $1.57 per acre on site 60 land to a high of $10.20 per acre on site index 90 land.

The very pronounced effect of the size of the discount rate on the annual productivity estimates can be seen by looking at site ind 90 land. Annual estimates ranged from $10.20 to -$2.42 as discount rates increased from 4.125 to 18 percent, Table 2.

Situation B: Annual Productivity Estimates for Land Already Planted to Timber

The analysis of situation A was simplified by the assumption th timberland was free of timber and trash. However, the current situation in the Y-LT Watershed is that over 500,000 acres of pine timber were planted between 1948 and 1970. [14/] Therefore, it is necessary to estimate the present value of existing stands and to convert this present value to annual productivity estimates.

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14 Appendix Table 6.

Table 2. Optimum rotations and annual equivalent estimates per acre for planted loblolly pine timber stands in the Yazoo-Little Tallahatchie Watershed, for four classes of timberland, by site index, for five rates of discount.

Discount rate	SITE INDEX 60		70		80		90	
	Rotation length	Annual equivalent estimates	Rotation length	Annual equivalent estimates	Rotation length	Annual equivalent estimates	Rotation length	Annual equivalent estimates
Percent	Years	Dollars	Years	Dollars	Years	Dollars	Years	Dollars
4.125	30	1.57	25	2.71	40	5.77	40	10.20
5.75	20	.80	25	1.71	40	3.80	40	6.92
7	20	.31	20	1.04	40	2.57	40	4.93
10	20	-.78	20	-.25	40	.34	40	1.57
18	20	-3.12	20	-2.92	20	-2.71	20	-2.42

Source: Appendix Tables 13 through 32.

The existing timber stands average about 13 years of age when weighted by acres planted per year. Therefore, an age of 13 was used as an example for this analysis. Present values range from $79.08 on site index 60 land to $368.85 on site index 90 land at the 4.125 percent discount rate, Table 3. As would be expected lower present values are associated with higher rates of discount for all site classes.

Annual productivity estimates for those trees already planted under the Y-LT project were estimated by multiplying the present value of the trees in the current year by the appropriate factor as given in Model (3), Appendix. These estimates are presented in Table 4. Values were estimated for the period from age 13 years to the end of the optimum rotation for a particular site index and discount rate. At the 4.125 percent discount rate annual productivity estimates ranged from $6.56 on site index 60 land to $22.91 on site index 90 land. For a discount rate of 7 percent, site index 80 timberland with a timber stand 13 years of age had an annual productivity estimate of $10.90 per acre from year 13 to year 40. If the landowner elected to engage in a planted loblolly pine timber enterprise on land of this quality for another optimum rotation at the same rate of discount, the estimated annual net value for the timber productivity for the duration of the most profitable rotation would be $2.57 per acre. Comparison of Tables 2 and 4 shows the difference in annual equivalent estimates between situations "A" and "B".

In summary, yields, assumed prices, costs and discount rates were incorporated into appropriate models to give present and annual

Table 3. Optimum rotations and present value per acre at age 13 years for planted loblolly pine timber stands in the Yazoo-Little Tallahatchie Watershed for four site classes and five rates of discount.

Discount rate	SITE INDEX 60		70		80		90	
	Optimum rotation length	Present value at age 13 years	Optimum rotation length	Present value at age 13 years	Optimum rotation length	Present value at age 13 years	Optimum rotation length	Present value at age 13 years
Percent	Years	Dollars	Years	Dollars	Years	Dollars	Years	Dollars
4.125	30	79.08	25	104.56	40	223.44	40	368.85
5.75	20	60.85	25	87.64	40	163.52	40	263.69
7	20	56.05	20	48.77	40	130.60	40	206.74
10	20	46.18	20	29.77	40	80.50	40	121.94
18	20	28.25	20	10.26	20	47.31	20	60.61

Source: Appendix Tables 13 through 32.

Table 4. Optimum rotations and annual equivalent estimates per acre for 13-year old planted loblolly pine timber stands in the Yazoo-Little Tallahatchie Watershed for four classes of timberland and five rates of discount.

Discount rate	SITE INDEX 60		70		80		90	
	Optimum rotation length	Annual equivalent values from 13 to optimum rotation	Optimum rotation length	Annual equivalent values from 13 to optimum rotation	Optimum rotation length	Annual equivalent values from 13 to optimum rotation	Optimum rotation length	Annual equivalent values from 13 to optimum rotation
Percent	Years	Dollars	Years	Dollars	Years	Dollars	Years	Dollars
4.125	30	6.56	25	11.22	40	13.88	40	22.91
5.75	20	10.80	25	10.31	40	12.07	40	19.46
7	20	10.40	20	13.87	40	10.90	40	17.25
10	20	9.49	20	12.65	40	8.71	40	13.20
18	20	7.41	20	9.88	20	12.41	20	15.90

Source: Appendix Tables 13 through 32.

uivalent value estimates for optimum rotations for two situations. ituation "A" provided estimates for timberland free of timber d trash. Situation "B" provided estimates for timberland containing anted loblolly stands 13 years old. Present and annual equivalent lue estimates for both situations for all rotations are presented in pendix Tables 13 through 32. Although no such cost comparisons were de in this study, it should be noted that normally sites containing crub" timber and/or trash would be more costly to plant to timber an would cleared land.

ALTERNATIVES FOR INCREASING TIMBER PRODUCTION EFFICIENCY

Landowners in the Y-LT Watershed have characteristics that are likely associated with high rates of discount. They are relatively old (74 percent are over 50 years of age); they have low incomes (61 percent earn less than $4500 annually); and they own small farm forests (93 percent own farm forests 300 acres or less in size), Appendix Table 1.

The above characteristics are indicative of an asset level, planning horizon and a level of uncertainty about the distant future that virtually precludes investment for distant future consumption. With little investment funds and short economic planning horizons, individuals are likely to use all available funds for current consumption or short-term investments. For examples, household appliances and other items are often financed at rates of interest in excess of those rates charged by more conventional institutional lenders. Current interest rates, even on loans from the latter agencies, are not conducive to forestry investment on much of the watershed lands. The analysis presented earlier shows a substantial variation in the productivity of planted timber for the rates of discount used. It is likely that typical landowners in the watershed discount future income at rates that approach one of the higher rates used in the analysis.

Alternatives to increase the productive efficiency of timber
t affect at least two aspects of the problem that currently
sts in the area. First, timber must be shown to be profitable
second, the expected payoff period must be reduced so that
nted timber will fall within the economic planning horizon of
landowners in the area.

Two alternative approaches are outlined. Either, if put into
ect, would increase the productivity of planted timber over current
ectations and provide annual payments to landowners. The alter-
rive approaches are: (1) an agency of cooperating owners of small
estland tracts, and (2) a government program (state or federal).

The proposals presented have only one major difference. One
poses to utilize existing agencies to provide timber investment
ds and administration; the other would necessitate the develop-
t of new agencies or programs. Both proposals are based on
annual productivity estimates presented earlier.

The general functions of the program and/or agency would be:
to serve as a source of operating funds, (b) to determine the
gibility of landowner participants, (c) to determine annual pro-
tivity estimates, (d) to establish procedures for entering and
aving the program, and (e) to provide administrative services in-
ding the distribution of annual payments, selling timber, and pro-
ling other professional and technical services essential to such
rogram.

An Agency of Cooperating Landowners

An agency of cooperating landowners, as proposed in the study, requires a unique organization. The functions which this type of agency must serve are reviewed below.

Sources of Operating Funds. Financing an agency of cooperating timberland owners designed to provide annual productivity payments would require a loan large enough and of sufficient duration to cove the expenses of forestry management supervision, general administrat n and the annual payments themselves.

If this type of organization is to be effective in lowering the discount rate, it is necessary that operating monies be borrowed at a rate that is less than the current discount rate of landowners, and i favorable to forestry investment. In this study it was assumed that annual productivity payments could be financed through monies borrowe from conventional financial institutions at interest rates of either 7 or 8 percent.

A detailed investigation of the cost of administration for this agency would be essential to estimate expected returns from planted timber enterprises. Such an investigation was beyond the scope of th study.

Discount rates of 7, 8, and 10 percent were used. Variation in discount rates allows comparison of estimated returns from planted timber at various levels of administrative costs. For example, opera funds might be secured for a 7 percent rate of interest. If 1 percen is added to cover the cost of administration, the discount rate for t agency would be 8 percent, Table 5.

ticipation in a Cooperating Agency of Small Forestland Owners. y those landowners in the Y-LT Watershed with planted timber stands who subsequently establish planted pine timber in a manner approved the agency or other authorized personnel would be eligible for ticipation in the agency. There would likely be no restrictions to farm size, income level, or asset holdings of participants in environment competitive for loan funds, timber sales, and other iness activities.

ermination of Annual Productivity Payments. Timber productivity t be estimated for each site index within a particular landowner ct. Annual payments would be based on the productivity estimate. example, assume 20 acres of bare timberland contain 10 acres of e index 70 and 10 acres of site index 80. The annual productivity imates for a 7 percent discount rate are as follows: 10 acres at 04 per acre or $10.40 per year, and 10 acres at $2.57 per acre or 5.70 per year, or a total annual productivity estimate of $36.10 for e 20 acres, Table 5. Because the timber productivity is estimated, might be desirable to base annual payments on some percentage of imated annual productivity in order to avoid overpayment. For ample, if 75 percent of the annual productivity estimate were used, e total figure would be $27.10. The annual productivity estimate uld continue for the duration of the optimum rotation for each te index.

Table 5. Annual per acre productivity estimates and 75 percent of these estimates, by site index, by optimum rotation, selected rates of discount, planted pine stands, Yazoo-Little Tallahatchie Watershed.

Site Index	Discount rate	Rotation length	Annual productivity	75 percent of annual productivity
	Percent	Years	Dollars	
60	7	20	.31	.23
60	8	20	-.07	-.05
60	10	20	-.78	-.59
70	7	20	1.04	.78
70	8	20	.59	.44
70	10	20	-.25	-.19
80	7	40	2.57	1.93
80	8	40	1.72	1.29
80	10	40	.34	.26
90	7	40	4.93	3.70
90	8	40	3.62	2.72
90	10	40	1.57	1.18

Source: Appendix Tables 13 through 32.

Estimates of the productivity of planted timber at a 7 percent rate of discount were presented primarily for comparison purposes and to give a more complete picture of the range of timber productivity under the conditions assumed in the study. A discount rate of 10 percent can be realized only on the best timberland sites in the watershed and even then the returns from timber enterprises are very low. Note that sites 60 and 70 timberlands do not yield a 10 percent return and that sites with an 80 or 90 index yield very low returns at the 10 percent rate of discount.

Plantations less than 20 acres in size would require determining the average site index and following the optimum rotation for a particular discount rate. In this way, the problems associated with timber management on several different optimum rotations on a small tract might be avoided. Larger plantations would be more easily divided for timber management according to the various site indices.

The program for an agency of cooperating land owners based on ual productivity estimates must contain some provision for determ- ng the annual productivity estimates for existing stands of planted e timber. The difference between annual productivity estimates existing stands and those for the bare land situation given earlier ld be the amount and the length of the period that the annual ductivity payments would be received. Annual equivalent estimates existing stands are larger since considerable value has already umulated, Table 6.

le 6. Annual per acre productivity estimates and 75 percent of these estimates by site index, by optimum rotation, selected discount rates, 13-year-old planted pine stands, Yazoo-Little Tallahatchie Watershed.

e : Index	Discount rate	Rotation length	Annual productivity	75 percent of annual productivity
	Percent	Years	Dollars	
)	7	20	10.40	7.80
)	8	20	10.09	7.57
)	10	20	9.49	7.12
)	7	20	13.87	10.40
)	8	20	13.45	10.09
)	10	20	12.65	9.49
)	7	40	10.90	8.18
)	8	40	10.08	7.56
)	10	40	8.71	6.53
)	7	40	17.25	12.94
)	8	40	15.71	11.78
)	10	40	13.20	9.90

urce: Appendix Tables 13 through 32.

For a 20 acre plantation of planted timber stands 13 years old and divided for management purposes into sites 70 and 80, the annual productivity estimates at the 7 percent rate of discount are as follows: 10 acres at $13.87 per acre or $138.70 per year for seven years and 10 acres at $10.90 per acre or $109.00 per year for 27 years, Table 6. Once these optimum rotations were completed and the landowner desires to begin another rotation the bare land annual productivity estimates in Table 5 are appropriate.

Productivity estimates at the 10 percent discount rate are positive on sites 60 and 70 until the end of the optimum rotation for the 13 year old plantations, Table 6. There are no positive net returns on these sites according to the bare land annual productivity estimates at the 10 percent discount rate presented in Table 5.

The techniques used in this study to estimate annual productivity are sufficiently flexible to estimate annual productivity for any realistic situation with regard to the current status of the site, relevant prices, yields and other variations in the situations presented in the example. In addition, these estimates can be provided by modern computers at a very low cost.

A practical deviation from the equal annual payments for stands already established would be as follows: The agency could make a lump sum payment equal to the present value or some proportion thereof, when the stands met eligibility requirements. Following the payment annual payments would revert to those indicated under situation "A".

Termination of Membership in the Agency. Cancellation of membership in the agency would necessitate that the landowner repay an amount

al to the annual productivity estimates plus interest at the cified discount rate through the termination date. In lieu of re- ing this total amount, some lien on the lands or timber rights reon must be imposed by the agency. Also specified would be the est date that the landowner could discontinue participation in the gram for a particular rotation. Such a restriction would be essary if the agency is to market the timber in an efficient manner.

eral Administration of the Agency. The administration of an agency landowners cooperating in timber production would consist of a board directors from the membership. These directors would employ the sonnel necessary to perform the management functions, service the rating loans , and issue annual productivity payments to the downer members.

Efficient administration of the agency would require that land- er accounts be maintained. Timber harvests would be contracted r a countywide or multi-countywide area by the agency. Acres to be vested would be determined by the age of the timber stands in ation to the most profitable rotations. The stands to be harvested a specified date would be located, cruised, marked, described and ertised for sale by the agency.

The landowner could be given the option to perform harvest oper- ons on his own stands and thereby receive the revenues from this ect of the timber enterprise. In this case, the agency would pro- e the management for the narvest operations with the landowner plying labor and machinery.

In summary, the general functions to be performed by an agency cooperating forestland owners have been reviewed. The annual

productivity estimates for two timberland situations and three rat of discount were presented. In terms of lowering the apparent dis count rate of the landowner participants, the 7 percent rate would o so. However, this rate does not include charges for administratio of the agency. Annual productivity estimates decline rather rapid when discount rates higher than 7 percent are used.

A Government Program

Review of existing government programs relative to land resou use indicates that precedents have been set for handling the kinds problems that might arise if an annual payments program based on ti ber productivity estimates were initiated.

Sources of Operating Funds. The Farmers Home Administration curre makes loans to public agencies for watershed and resource developme at interest rates that range from 3.463 to 5 percent with a payout period ranging from 30 to 50 years.[15/] Title III of Economic Opportunity Act of 1964 authorized the Office of Economic Opportuni in cooperation with the Farmers Home Administration to initiate a l program designed to help low-income rural families.[16/] Loans have been made by this agency to "low-income farmers" at an interest rat

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15/ Farmers Home Administration, U. S. Department of Agricult Washington, D. C.

16/ U. S. Statue, Economic Opportunity Act 1964; P. L. 88-452 78 Stat. 508; 42 USC 2701, 2711-2720, 2731-2736; 2751-2756, 2761, 2781-2791, 2801-2807, 2821, 2822, 2831, 2841, 2851-2854, 2861, 2871 2881, 2901-2907, 2921-2923; 2941-2949, 2961-2966, 2981.

: 4.125 percent for a maximum period of 15 years.[17] Since these
)ans are available at an interest rate of 4.125 percent, timber
:oductivity in the watershed was estimated at that rate of discount.
ie major changes in this program to adapt it to forestry enterprises
)uld be an increase in the maximum period of the loan and the total
iount loaned per individual.

The federal government also currently finances land and water
:source development projects at a discount rate based upon the aver-
ge rate of interest payable by the Treasury on interest-bearing
irketable securities of the United States.[18] Monies have been made
'ailable recently at 5.75 percent for such projects as U. S. Army
)rps of Engineer stream channelization and watershed dams.

Use of public monies for forestry investments by low-income small
indowners at either of the above rates would seem justifiable. Loans
)r annual payments could be serviced as are those now being handled
irough existing agencies.

.igibility. Only those landowners in the Y-LT Watershed who current-
' own or subsequently establish planted timber stands on sites
)proved by a professional forester or other appropriate authority

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17/ For a discussion of the operation of this loan program in the
)rtheast hill area of Mississippi see: Yonge, Jim L., "An Economic
.)praisal of the EO-Title III Loan Program in Northeast Mississippi,"
Jnpublished Master's Thesis, Department of Agricultural Economics,
ssissippi State University, State College, Missisippi, January 1968).

18/ "Policies, Standards, and Procedures in the Formulation,
'aluation and Review of Plans for Use and Development of Water and
:lated Land Resources", Senate Review Document No. 97, U. S.
)vernment Printing Office, Washington, D. C. 1962.

would be eligible for participation in the program. It would likel be desirable to further restrict eligibility according to farm size annual income, and other asset holdings. The specific restrictions could be made after further study by professionals from the area.

Determination of the Annual Payments. Timber productivity must be estimated for each site index within a particular landowner tract. Annual payments would be based on the productivity estimates. For example, on 20 acres of bare timberland containing 10 acres of site index 70 and 10 acres of site index 80, the annual productivity estimates for a 4.125 percent discount rate would be as follows: 1(acres at $2.71 per acre or $27.10 per year and 10 acres at $5.77 pe acre of $57.70 per year for a total annual productivity of $84.80 f the 20 acre tract, Table 7.

If productivity estimates are discounted at the 5.75 percent rate the annual payments are lower. For the same 20 acre example, the annual productivity estimates are: 10 acres at $1.71 per acre or $17.10 per year, and 10 acres at $3.80 per acre or $38.00 per yea Table 7. The annual productivity estimate for the 20 acre plantation would be $55.10. To avoid over payment, an arbitrary amount, say 75 percent of the annual productivity estimates could be paid.

In this program there must be a method for determining the annual equivalent estimates for existing plantations. The differenc between this existing timber stand situation and the bare land situation discussed in the foregoing paragraphs is the amount and duration of the annual productivity estimates. Annual equivalent estimates are larger since considerable value may have accumulated.

ble 7. Annual per acre productivity estimates and 75 percent of these estimates, by site index, by optimum rotation, selected rates of discount, planted pine stands, Yazoo-Little Tallahatchie Watershed.

te Idex	Discount rate	Rotation length	Annual Productivity	75 percent of annual Productivity
	Percent	Years	Dollars	
0	4.125	30	1.57	1.18
0	5.75	20	.80	.60
0	4.125	25	2.71	2.03
0	5.75	25	1.71	1.28
0	4.125	40	5.77	4.33
0	5.75	40	3.80	2.85
0	4.125	40	10.20	7.65
0	5.75	40	6.92	5.19

urce: Appendix Tables 13 through 32.

The annual productivity estimates for a 20 acre plantation vided into site index 70 and 80 containing a stand of 13 year old loblolly pine timber discounted at the 4.125 percent rate are as llows: 10 acres at $11.22 per acre or $112.20 per year and 10 acres $13.88 per acre or $138.80 per year, Table 8. Note that these timates would be for 12 year and 27 year periods, respectively. nual productivity estimates discounted at the 5.75 percent rate for e same plantation are also presented in Table 8. As with the other ogram, lump sum payments would be possible.

Table 8. Annual per acre productivity estimates and 75 percent of those estimates, by site index, by optimum rotation, selected discount rates, 13 year old planted pine stands, Yazoo-Little Tallahatchie Watershed.

Site Index	Discount rate	Rotation length	Annual productivity	75 percent of annual productivit
	Percent	Years	Dollars	
60	4.125	30	6.56	4.92
60	5.75	20	10.80	8.10
70	4.125	25	11.22	8.42
70	5.75	25	10.31	7.73
80	4.125	40	13.88	10.41
80	5.75	40	12.07	9.05
90	4.125	40	22.91	17.18
90	5.75	40	19.46	14.60

Source: Appendix Tables 13 through 32.

If the landowner agreed to participate in one or more additiona optimum timber rotations once the present stand was harvested, then the bare land annual equivalent estimates in Table 7 would be approp-at

Provisions for Entering and Leaving the Government Program. A govern ment program providing payments for annual productivity estimates should allow for some means for getting into and out of the program. Participation in an annual payments program would require that the producer meet eligibility requirements and sign a contractual agree- ment. Assets to serve as security for annual payments would be specified in the contract. The contract would specify the terms for leaving the program, including repayment of past payments plus inter est at the specified discount rate. Also specified would be the latest date that the landowner could discontinue participation in th

program for a particular rotation. Such a restriction would be necessary if the controlling government agency is to market the timber in an efficient manner.

Administration of the Proposed Program. Efficient administration of a program would require that landowner accounts be maintained. Financing might be arranged through the Farmers Home Administration in cooperation with the Agricultural Stabilization and Conservation Service, with the latter rendering the supervision during participation. Similar agencies at the state or federal level might also perform this function.

Timber harvests would be contracted over a countywide or multi-countywide area by the agency. Acres to be harvested would be determined by the age of the timber stands in relation to the most profitable rotations. The stands to be harvested by a specified date would be located, cruised, marked, described and advertised for sale by the agency.

The landowner could be given the option to perform harvest operations on his own stands and thereby receive the revenues from this aspect of the timber enterprise. In this case, the sponsoring agency would continue to provide forest management for the harvest operations.

In summary, if the government (state or federal) were to allocate funds at low interest rates for payments to landowners based on annual productivity estimates from timber, profitability of timber to individual landowner would be increased, and with annual productivity payments planted timber might become a realistic alternative for land resource use.

Existing government agencies have expertise in timber management, the servicing of agricultural production loans, and the supervision that is necessary when public monies are expended.

General Problems in the Proposals

Implicit with a program of annual productivity payments for timber production is the idea of lending money with the expectation of repayment at some specified future date. Whenever a loan of any type is made, whether by an institutional lender or an individual, security is customarily made for the amount loaned.

An annual income payments program, whether developed by government or private enterprise, would likely involve the two timberland situations as analyzed earlier. The open-land situation and the situation of an existing timber stand are likely to pose different problems when questions are raised regarding the security of the investor's monies.

In the case of open land where the landowner wishes to receive annual productivity payments, the lender must have some assurance tha the seedling trees will receive husbandlike management until the tree reach a certain age. Further, the investor must have invested funds insured against financial loss from fires and similar damages. In an event, the investor must have some assurance that revenues from futur timber harvests are realizable. The details necessary to lessen the risks, whether the investor is government or private enterprise, would be outlined in a detailed contractual agreement.

In the case of an already existing timber stand where the landowner desires lump-sum and/or annual income payments for timber

productivity, the investor must have sufficient protection from financial loss through fires or similar hazards. Further, the investor must have assurance that any harvesting of timber will take place as prescribed in a management agreement. In the event that harvests do occur at times other than outlined in the original management agreement the landowner would be liable for the annual productivity payments received plus accrued interest.

In both land situations presented above, if the landowner desired to change land use or otherwise remove his land from the program, repayment of the annual payments plus interest would be necessary to secure the investor's monies.

SUMMARY AND EVALUATION

The purpose of this study was to evaluate an annual income payment scheme as to its potential for increasing the production efficiency of planted timber stands in the Y-LT Watershed. The specific objectives were: (1) to estimate timber productivity by site index classification and value this productivity at selected rates of discount, for specified costs and product prices, and (2) to evaluate alternative schemes for providing owners of small forestland tracts with an income payment in accordance with annual productivity of these planted stands.

Yield data from 99 loblolly pine timber plots in the Y-LT Watershed were provided by the project personnel.

Prices of $6 per cord for pulpwood and $50 per thousand board feet for sawtimber were used in the study.

Costs of $20 per acre for open land planting and $0.60 per cord for marking trees for thinning were used in the analysis.

Discount rates used in the study were 4.125, 5.75, 7, 8, 10 and 18 percent.

Present value models were used to discount future revenues and costs of planted pine timber stands on four site classes of timberland. Capitalized values were obtained by estimating the present value of a single rotation repeated in perpetuity. Optimum rotations for four site classes and six discount rates were determined by selecting the largest capitalized value for a given discount rate and

ite class. Annual productivity estimates were obtained from these apitalized values.

Annual productivity estimates were determined for two land ituations: timberland free of timber and trash, and for existing tands of planted pine timber. These situations were chosen as xamples of the timberland situations in the study region.

The annual productivity estimates for land free of timber and rash ranged from $1.57 per acre on the poorest site quality to 10.20 per acre on the best site quality at the lowest discount rate, .125 percent. There were negative returns on all sites for the 18 ercent discount rate, a rate which may closely approximate the urrent discount rate of many landowners in the area.

The present value for stands of trees 13 years of age (the pproximate weighted average age of trees planted under the Y-LT rogram) was estimated for the respective optimum rotations. Annual roductivity estimates for 13-year-old planted pine timber stands anged from $6.56 per acre on the poorest timber site to $22.91 er acre on the best site at the 4.125 percent discount rate. The argest annual productivity estimates on the best site at 18 percent iscount rate was $15.90 per acre. The annual productivity estimates re higher for the 13-year-old plantation since substantial value as accumulated in these timber stands.

Two alternative proposals that would lower the landowner's pparent discount rate and provide for annual productivity payments ased on timberland productivity were presented in the study.

The first proposal, an agency of cooperating landowners, would require the development of a new organizational framework, It woul be necessary for this agency to borrow operating funds through some conventional financial institution at the market rate of interest. The second proposal would utilize existing government programs and agencies to achieve decreased discount rates and provide annual payments.

Evaluation of Proposals

Either proposal, if adopted, would tend to increase the productive efficiency of planted timber in that both provide rates of interest lower than the apparent discount rates of the landowners in the area.

For the agency of cooperating landowners it was assumed that t lowest interest rate at which operating monies could be obtained wa 7 percent. At this discount rate annual productivity payments woul range from $0.31 per acre on the poorest site to $4.93 on the best site. These estimates do not include the cost of adminstration and management by the agency. With these added costs, the discount rat for such an organization under current conditions would likely exce 7 percent. For the 8 and 10 percent rates of discount, timber can be profitably produced in the Y-LT Watershed only on a selected sit basis. This fact alone would present difficulties in establishing contiguous timber tract for management purposes. The agency of cooperating landowners would not likely attract a large number of participants unless operating monies could be obtained at an intere rate lower than 8 percent.

The government proposal assumed that operating monies could be stified at the 4.125 or 5.75 percent discount rates. At both rates turns from planted timber are such that this enterprise could well mpete for the resources. At a 4.125 percent discount rate, annual oductivity payments would range from $1.57 per acre on the poorest te to $10.20 per acre on the best site.

Either approach would be consistent with the goals of increased ployment in rural areas, conservation of resources, and preservation other aesthetic values. Under either approach, it may be necessary subsidize owners of very unproductive lands for timber production the Y-LT Watershed to prevent soil erosion and enhance other values. so, the project personnel would be knowledgeable in describing ose lands where subsidized timber production would be necessary. fact, a "rough draft" of a "conservation assurance program" that oposes an incentive payment has been prepared by personnel of the LT Watershed Project. Some combination of all the proposals dis-ssed would appear feasible.

One of the limitations encountered in consolidation of small nerships for production efficiency is the costs associated with nsolidation. Landline maintenance or ground indentification of antations would likely necessitate additional surveying. The ansportation network or the logging roads necessary for efficient rvesting would probably increase the costs of consolidation. This uld be minimized if enough public roads are maintained in the area. ere is sufficient evidence that the cost of marking trees for thin-ng is likely to increase in the future. Fire protection is a must carrying out any timber production program. Costs of forest

supervision are likely to increase with a certain amount of "wheel-spinning" associated with the management of many small tracts over a large geographical area. Negotiation costs or those costs incurred in getting contracts agreed upon must be recognized as a limitation in consolidating ownerships.

Implications for Future Research

Improvement over the data used in the study might be achieved in three areas: timber yields, product prices, and costs of timber management and harvesting. Significant changes in any of these variables or combinations would necessitate new productivity estimates.

While the actual timber yields were the best available in the area, more productive pine varieties have been developed. Also, the first plantings were on the most critically eroded sites. It is likely that future plantings will be, on the average, on better quality timber sites. Future research is needed to obtain yields in these situations.

In areas where timber occupies such a large proportion of the land area more comprehensive soil maps for timber production would be helpful. Soil quality, determination and classification for timber production is necessary for accurate productivity estimates and efficiency in administration of any program based on these estimates.

This study made no attempt to project timber prices. Future research in timber marketing and price prediction would facilitate accuracy in developing the productivity estimates.

Better estimates of management and harvesting costs on small ownerships are needed for comparison with these same costs if these ownerships were to be consolidated.

Estimates of the impact of an annual payments program on the economy of the region is an area for future research effort. Such study could well outline the importance of timber production on the region's economy.

As outlined in the implications section, certain areas must be considered in proper perspective. When reviewed in terms of the premature clearcutting of pine timber in the study area and the possible solutions to this problem, an annual payments approach to increased production efficiency on small timberland tracts does seem operational and reasonable.

APPENDIX

CONCEPTUAL PROBLEMS AND PROCEDURES

The concept of investment as it applies to forestry is briefly examined in this section. The peculiarities that make forestry investment different from annual enterprises are set forth and discounting techniques to estimate annual equivalent returns from forestry enterprises are reviewed.

Factors Affecting Investment Decisions

Investment is undertaken in anticipation of future wealth or income through foregoing current consumption. Prior to answering questions relative to a particular investment decision by an individual, consideration must be given to some variables which are basic to any investment. Time preference or the degree to which an investor prefe current income over future income, the planning horizon or the extent to which an investor plans into the future, and some assessment of th investor's view of the uncertainty of expected future income are important variables in explaining why an individual accepts or requires different rates of return on invested funds.

The rate at which an individual discounts future costs and returns is also a manifestation of the level or intensity of the abov three variables. The rate of discount is, in turn, of major importance in determining the present value of a stream of future benefits and costs from an investment venture. High rates of discount due to the uncertainties of future income from forestry, is consistent with

low present value of expected future income. In this case, the onditions necessary for economic efficiency in production from ociety's point of view (lower rates of discount) are not likely to e met. These conditions are presented in detail in numerous texts nd will be treated only briefly here. Heady states that a necessary ondition for economic efficiency is that "given resources must be ombined in such a manner that they cannot be rearranged to give a) a greater physical product with the same collection of resources, r (b) the same physical product with less of one or more re-ources."[1/] The sufficient condition as defined by the same author is enoted "when resources are used in such a manner to maximize the articular objective or end quantity which is relevant to the economic nit under consideration."[2/] If profit maximization is the objective f the economic unit under consideration, then the necessary condition s that marginal value product equals marginal factor cost.

In comparing investment alternatives, then, it is the value of ne individual discount rate which will make an investment alternative omparable to the next best rate of return for the individual's funds r resources. The point here is that time preference rates, planning orizons, and uncertainty of expected future income as reflected in ne discount rate vary among individuals and groups of individuals. iscount rates vary for a variety of reasons, but basically they are

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1/ Heady, E. O., Economics of Agricultural Production and esource Use, Prentiss-Hall, Inc., Englewood Cliffs, New Jersey, 965, p. 95.

2/ Ibid., p. 99.

influenced by the economic situation of the individual, his ultimat goals, and his knowledge about the availability of investment alter natives. If the individual's rate of discount can be affected, the his investment alternatives might be changed.

Investment in Forestry

Investment in forestry is a form of capital accumulation in that an increment of capital is formed during each growing season but cannot be recouped until a much later time period and, therefor is not available to meet annual needs for income.

Difficulty in evaluating the annual earning capacity of an investment in timber further complicates the decision to invest in planted timber. Costs of production are generally incurred early in the production period and returns are realized much later. Therefore, the entrepreneur is compelled by the nature of an investment in timber to forego any interest that accrues on funds o resources invested in forestry until harvest is realized.3/

3/ Hiley, W.E., Economics of Plantation, Faber and Faber Limi 24 Russell Square, London, 1956, pp. 21-22.

nsequently, the interest that accrues on funds or resources invested forestry must be compounded or discounted.

An annual payment based on productivity might help to bring vestment in intensive forest management well within the planning rizon of the individual landowner.

Implicit in the hypothesis that annual payments will increase the oductive efficiency of forestland resources held in small ownerships : (1) that these resources are, from society's viewpoint, currently ed inefficiently; and (2) that under certain conditions investment intensive forest management on small forestland ownerships is a ofitable alternative.

As pointed out earlier, the higher rate at which some individuals discount expected future income may be associated with ineffi-ency in resource use from society's point of view.

Discounting and Annual Equivalent Models

If the land resources held by Y-LT owners are to be allocated to estry enterprises, then the returns from such enterprises must be on a basis in time comparable to the returns from alternate enter-ses which, by and large, produce annual returns.

The problem is to estimate the productivity of planted timber on annual basis so that investors can compare annual returns from tim- with returns from alternative land uses. To evaluate returns from ber on an annual basis all future costs and returns from a given ber rotation must be discounted to a present value and this value t then be put in terms of an annual equivalent amount. An annual

equivalent could be defined as a stream of annual income payments equal to future net revenues from the timber enterprise.

Present Value Models[4/]

The specific mathematical model used to obtain estimates of t present net value of a single timber rotation was:

$$PNV_{SR} = \sum_{j=1}^{M} \left(\frac{Y_j P_j}{(1 + r)^{n_j}} - \frac{C_j}{(1 + r)^{n_j}} \right) - R \quad ($$

where: PNV_{SR} = the estimated present net value of a single rotat

Y_j = the estimated yield in the number of appropriate units for the j^{th} sale,

P_j = the estimated price per unit of timber in dollars for the j^{th} sale,

n_j = the number of years until the j^{th} sale occurs,

$j = 1, 2, \ldots m$, where m = the number of sales or c of timber that occur during the given rotation an cutting schedule,

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4/ Discounting-compounding techniques are treated at length numerous texts: Boulding, Kenneth E., Economic Analysis, 4th Editi Harper and Row, New York, N. Y., 1966; Heady, E. O., Economics of Agricultural Production and Resource Use, Prentice-Hall, Inc., Engl wood Cliffs, New Jersey, 1965, and others. Extensions of these bas models have been recently used by Row and Holmes in the following works: Row, Clark, Determining Forest Investment Rates-of-Return b Electronic Computer, U. S. Forest Research Paper, SO-6, Southern Forest Experiment Station, 1963; Holmes, Mac Reese, "An Applicatio Quantitative Economic Analysis to Forest Management Problems", Un- published doctoral dissertation, Department of Agricultural Economi Mississippi State University, State College, Mississippi, May 1970.

C_j = the periodic cost associated with the management of a timber stand. $j = 1, 2, \ldots m$.

r = the discount rate as a decimal number, and

R = the cost of establishing the stand.

The capitalized value of a planted timber stand is all future net revenues discounted to the present of a single rotation repeated in perpetuity. To obtain the capitalized value (the bareland value or the value in perpetuity) equation (1) is multiplied by an appropriate factor to give (2).

$$PNV_{ISR} = \left[\sum_{j-1}^{M} \left(\frac{Y_j P_j}{(1 + r)^{n_j}} - \frac{C_j}{(1 + r)^{n_j}} \right) - R \right] \left[1 + \frac{1}{(1 + r)^{L} - 1} \right] \qquad (2)$$

Where: PNV_{ISR} = the present net value of an infinite series of timber rotations, other variables are as defined in equation (1),

L = the length of the rotation.

Annual equivalent values of timber rotations in perpetuity are obtained by multiplying the rate of discount by the capitalized values of such rotations.

The annual equivalent values for a single rotation are somewha more complicated since the single rotation values must be modified s follows: 5/

$$AE_{SR} = \left[PNV_{SR} \right] \left[\frac{r\ (1 + r)^{L}}{(1 + r)^{L} - 1} \right] \quad (3$$

where: AE_{SR} = the annual equivalent value for a single timber rotation,

r = the discount rate as a decimal, and

L = the length of the rotation.

The planted timber in the Y-LT Watershed may range from one t 22 years of age. The present net value of a single rotation at an year or age K is given by:

$$PNV_{K} = \sum_{j=1}^{M} \frac{R_j}{(1 + r)^{(N_j - K)}} - \sum_{j=1}^{M} \frac{C_j}{(1 + r)^{(N_j - K)}} \quad (4$$

where: PNV_K = the present net value of a rotation in year K,

R_j = the revenue from a given timber sale,

C_j = the periodic cost incurred in a timber rotation from year K to the end of the rotation,

$j = 1, 2, \ldots, m$ = the number of sales and/or costs tha

5/ The term $\left[\frac{r\ (1 + r)^{L}}{(1 + r)^{L} - 1} \right]$ when multiplied by the presen value of an annuity will yield the amount of the annuity.

occur during the given timber rotation and cutting schedule,

K = the age of the given timber stand,

N_j = the year that a given revenue and/or cost occurred, $j = 1, 2, \ldots, m$.

The annual equivalent value (or in the case of timber, the annual productivity) is then obtained as in equation (3).

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endix Table 1. Number and percent of total landowners by age, income level, farm forest acres, and plantation size, Yazoo-Little Tallahatchie Watershed, Mississippi, 1966.

m	Number	Percent of total
group:		
Less than 30 years	102	1.1
30-49 years	2,293	24.6
50-59 years	3,581	38.4
60 or more years	3,338	35.9
Not reported	0	0.0
Total	9,314	100.0
ber with income of:		
Less than $1,500	1,032	11.1
$1,500-$2,999	1,823	19.6
$3,000-$4,499	2,560	27.5
$4,500 or more	3,646	39.2
Not reported	253	2.6
Total	9,314	100.0
ber with farm forest acres of:		
0- 20 acres	1,958	21.0
21-100 acres	4,508	48.4
101-300 acres	1,879	20.2
301 or more acres	657	7.1
Not reported	312	3.3
Total	9,314	100.0
ber with plantation of:		
2- 20 acres	4,762	51.1
21-100 acres	3,332	35.8
101-300 acres	677	7.3
301 or more acres	126	1.3
Not reported	417	4.5
Total	9,314	100.0

ce: Unpublished data from Yazoo-Little Tallahatchie Project Headquarters, Oxford, Mississippi.

Appendix Table 2. SITE INDEX 60: Estimated harvested yields per acre of pulpwood and sawtimber from planted loblolly pine timber stands in the Yazoo-Little Tallahatchie Watershed when thinned back to 100 square feet basal area by rotation length, by age of stand.

Age of stand	Rotation lengths in years					
	15	20	25	30	35	40
Years						
			PULPWOOD CORDS			
15	3	-	-	-	-	-
20		15	2 1/	2	2	2
25			18	5	5	5
30				18	4	4
35					19	4
40						19
			SAWTIMBER 2/ Thousand Board Feet			
40						0

1/ Some foresters may feel that thinning two cords per acre is impractical; however, failure to thin this small quantity would have little effect on the analysis.

2/ Sawtimber given in Scribner log scale.

ppendix Table 3. SITE INDEX 70: Estimated harvested yields per acre of pulpwood and sawtimber from planted loblolly pine timber stands in the Yazoo-Little Tallahatchie Watershed when thinned back to 100 square feet basal area by rotation length, by age of stand.

e of and ars	Rotation lengths in years					
	15	20	25	30	35	40
	PULPWOOD CORDS					
15	8	-	-	-	-	-
20		20	3	3	3	3
25			25	7	7	7
30				25	5	5
35					26	5
40						8
	SAWTIMBER[1/] Thousand Board Feet					
40						2.3

1/ Sawtimber given in Scribner log scale.

Appendix Table 4. SITE INDEX 80: Estimated harvested yields per acre of pulpwood and sawtimber from planted loblolly pine timber stands in the Yazoo-Little Tallahatchie Watershed when thinned back to 100 square feet basal area by rotation length, by age of stand.

Age of stand	Rotation lengths in years					
	15	20	25	30	35	40
Years						
			PULPWOOD CORDS			
15	12	2 1/	2	2	2	2
20		21	6	6	6	6
25			26	8	8	8
30				29	7	7
35					30	7
40						6
			SAWTIMBER 2/			
			Thousand Board Feet			
40						6.

1/ Some foresters may feel that thinning two cords per acre is impractical; however, failure to thin this small quanti would have little effect on the analysis.

2/ Sawtimber given in Scribner log scale.

Appendix Table 5. SITE INDEX 90: Estimated harvested yields per acre of pulpwood and sawtimber from planted loblolly pine timber stands in the Yazoo-Little Tallahatchie Watershed when thinned back to 100 square feet basal area by rotation length, by age of stand.

Age of stand	Rotation lengths in years					
Years	15	20	25	30	35	40
	PULPWOOD CORDS					
15	16	3	3	3	3	3
20		26	8	8	8	8
25			35	8	8	8
30				39	9	9
35					40	10
40						4
	SAWTIMBER[1/] Thousand Board Feet					
40						14.3

Source: Unpublished data from Yazoo-Little Tallahatchie Project Headquarters, Oxford, Mississippi.

1/ Sawtimber given in Scribner log scale.

Appendix Table 6. Year established, net acres planted each year, and cumulative total acres of planted loblolly pine timber stands in the Yazoo-Little Tallahatchie Watershed from 1948 through 1970.

Year established	Net acres planted	Cumulative total acres planted	Year established	Net acres planted	Cumulative total acres planted
1948	316	316	1960	39,903	270,521
1949	1,574	1,890	1961	34,893	305,414
1950	4,373	6,263	1962	31,327	336,741
1951	11,986	18,249	1963	29,203	365,944
1952	8,789	27,038	1964	23,961	389,905
1953	20,002	47,040	1965	21,792	411,697
1954	16,722	63,762	1966	22,121	433,818
1955	19,718	83,480	1967	17,938	451,756
1956	33,470	116,950	1968	20,715	472,471
1957	33,519	150,469	1969	15,279	487,750
1958	40,245	190,714	1970	20,935	508,685
1959	39,904	230,618			

Source: Unpublished data from the Yazoo-Little Tallahatchie Watershed Project, Oxford, Mississippi.

ppendix Table 7. Hypothetical undiscounted costs and returns per acre of a 40-year rotation of planted loblolly pine timber in Yazoo-Little Tallahatchie, on timber site 90 and present net worth of these costs and returns at selected discount rates.

tem	Year	Unit	Quantity	Price	Amount
				------Dollars-------	
mber sale					
Pulpwood	15	cords	3	6.00	18.00
Pulpwood	20	cords	8	6.00	48.00
Pulpwood	25	cords	8	6.00	48.00
Pulpwood	30	cords	9	6.00	54.00
Pulpwood	35	cords	10	6.00	60.00
Pulpwood	40	cords	4	6.00	24.00
Sawtimber	40	MBF[a/]	14.3	50.00	715.00
Total Revenue					967.00
xpenses					
Thinning	15	cords	3	.60	1.80
Thinning	20	cords	8	.60	4.80
Thinning	25	cords	8	.60	4.80
Thinning	30	cords	9	.60	5.40
Thinning	35	cords	10	.60	6.00
Total Periodic Costs					22.80
Planting costs per acre					20.00
Total Expenses					42.80
ndiscounted returns above specified expense					925.20
resent Net Worth at:					
4.125 percent					198.09
5.75 percent					107.48
7 percent					65.78

a/ Thousand board feet Scribner Scale.

Appendix Table 8. Hypothetical undiscounted costs and returns per acre of a 40-year rotation of planted loblolly pine timber in Yazoo-Little Tallahatchie, on timber site 80 and present net worth of these costs and returns at selected discount rates.

Item	Year	Unit	Quantity	Price	Amount
				------Dollars-----	
Timber sale					
Pulpwood	15	cords	2	6.00	12.00
Pulpwood	20	cords	6	6.00	36.00
Pulpwood	25	cords	8	6.00	48.00
Pulpwood	30	cords	7	6.00	42.00
Pulpwood	35	cords	7	6.00	42.00
Pulpwood	40	cords	6	6.00	36.00
Sawtimber	40	MBF[a/]	6.9	50.00	345.00
Total Revenue					561.00
Expenses					
Thinning	15	cords	2	.60	1.20
Thinning	20	cords	6	.60	3.60
Thinning	25	cords	8	.60	4.80
Thinning	30	cords	7	.60	4.20
Thinning	35	cords	7	.60	4.20
Total Periodic Costs					18.00
Planting cost per acre					20.00
Total Expenses					38.00
Undiscounted returns above specified expense					523.00
Present net worth at:					
4.125 percent					112.11
5.75 percent					59.05
7 percent					34.19

a/ Thousand board feet Scribner Scale.

Appendix Table 9. Hypothetical undiscounted costs and returns per acre of a 40-year rotation of planted loblolly pine timber in Yazoo-Little Tallahatchie, on timber site 70 and present net worth of these costs and returns at selected discount rates.

Item	Year	Unit	Quantity	Price	Amount
				------Dollars-------	
Timber sale					
Pulpwood	20	cords	3	6.00	18.00
Pulpwood	25	cords	7	6.00	42.00
Pulpwood	30	cords	5	6.00	30.00
Pulpwood	35	cords	5	6.00	30.00
Pulpwood	40	cords	8	6.00	48.00
Sawtimber	40	MBF[a/]	2.3	50.00	115.00
Total Revenues					283.00
Expenses					
Thinning	20	cords	3	.60	1.80
Thinning	25	cords	7	.60	4.20
Thinning	30	cords	5	.60	3.00
Thinning	35	cords	5	.60	3.00
Total Periodic Costs					12.00
Planting cost per acre					20.00
Total Expenses					32.00
Undiscounted returns above specified expense					251.00
Present net worth at:					
4.125 percent					42.03
5.75 percent					25.86
7 percent					16.48

a/ Thousand board feet Scribner Scale.

Appendix Table 10. Hypothetical undiscounted costs and returns per acre of a 40-year rotation of planted loblolly pine timber in Yazoo-Little Tallahatchie, on timber site 60 and present net worth of these costs and returns at selected discount rates.

Item	Year	Unit	Quantity	Price	Amount
				------Dollars-----	
Timber sale					
Pulpwood	20	cords	2	6.00	12.00
Pulpwood	25	cords	5	6.00	30.00
Pulpwood	30	cords	4	6.00	24.00
Pulpwood	35	cords	4	6.00	24.00
Pulpwood	40	cords	19	6.00	114.00
Total Revenue					204.00
Expenses					
Thinning	20	cords	2	.60	1.20
Thinning	25	cords	5	.60	3.00
Thinning	30	cords	4	.60	2.40
Thinning	35	cords	4	.60	2.40
Total Periodic Costs					9.00
Planting cost per acre					20.00
Total Expenses					29.00
Undiscounted returns above specified expense					175.00
Present net worth at:					
4.125 percent					28.94
5.75 percent					9.47
7 percent					.24

ppendix Table 11. Hypothetical undiscounted costs and returns per acre of a 25-year rotation of planted loblolly pine timber in Yazoo-Little Tallahatchie, on timber site 70 and present net worth of these costs and returns at selected discount rates.

tem	Year	Unit	Quantity	Price	Amount
				------Dollars-------	
imber sale					
Pulpwood	20	cords	3	6.00	18.00
Pulpwood	25	cords	25	6.00	150.00
Total Revenue					168.00
xpenses					
Thinning	20	cords	3	.60	1.80
Total Periodic Costs					1.80
Planting cost per acre					20.00
Total Expenses					21.80
ndiscounted returns above specified expense					146.20
resent net worth at:					
4.125 percent					41.82
5.75 percent					22.37
7 percent					11.82

Appendix Table 12. Hypothetical undiscounted costs and returns per acre of a 30-year rotation of planted loblolly pine timber in Yazoo-Little Tallahatchie, on timber site 60 and present net worth of these costs and returns at selected discount rates.

Item	Year	Unit	Quantity	Price	Amount
				------Dollars------	
Timber sale					
Pulpwood	20	cords	2	6.00	12.00
Pulpwood	25	cords	5	6.00	30.00
Pulpwood	30	cords	18	6.00	108.00
Total Revenue					150.00
Expenses					
Thinning	20	cords	2	.60	1.20
Thinning	25	cords	5	.60	3.00
Total Periodic Costs					4.20
Planting cost per acre					20.00
Total Expenses					24.20
Undiscounted returns above specified expense					125.80
Present net worth at:					
4.125 percent					26.76
5.75 percent					10.39
7 percent					1.95

Appendix Table 13. SITE INDEX 60, 20 YEAR ROTATION: Present and annual equivalent values for a single rotation, capitalized values, present values at age 13 years, and annual equivalent value year 13, dollars per acre, for planted loblolly pine timber stands in the Yazoo-Little Tallahatchie Watershed at six discount rates.*

Discount rates	Present value single rotation	Annual equivalent	Capitalized value	Present value at age 13 years	Annual Equivalent year 13
Percent			Dollars per acre		
4.125	20.10	1.50	36.25	67.82	11.35
5.75	9.42	.80	13.99	60.85	10.80
7	3.26	.31	4.39	56.05	10.40
8	-.69	-.07	-.879	52.51	10.09
10	-6.62	-.78	-7.77	46.18	9.49
18	-16.71	-3.12	-17.35	28.25	7.41

* Prices used are $6 per cord for pulpwood and $50 per thousand board feet Scribner Scale.

Appendix Table 14. SITE INDEX 60, 25 YEAR ROTATION: Present and annual equivalent values for a single rotation, capitalized values, present values at age 13 years, and annual equivalent value year 13, dollars per acre, for planted loblolly pine timber stands in the Yazoo-Little Tallahatchie Watershed at six discount rates.*

Discount rates	Present value single rotation	Annual equivalent	Capitalized value	Present value at age 13 years	Annual Equivalent year 13
Percent	Dollars per acre				
4.125	24.13	1.56	37.94	74.63	8.01
5.75	10.22	.78	13.58	62.52	7.35
7	2.69	.23	3.30	54.68	6.88
8	-1.91	-.18	-2.24	49.19	6.53
10	-8.43	-.93	-9.28	39.95	5.86
18	-17.88	-3.27	-18.17	18.21	3.80

* Prices used are $6 per cord for pulpwood and $50 per thousand board feet Scribner Scale.

Appendix Table 15. SITE INDEX 60, 30 YEAR ROTATION: Present and annual equivalent values for a single rotation, capitalized values, present values at age 13 years, and annual equivalent value year 13, dollars per acre, for planted loblolly pine timber stands in the Yazoo-Little Tallahatchie Watershed at six discount rates.*

Discount rates	Present value single rotation	Annual equivalent	Capitalized value	Present value at age 13 years	Annual Equivalent year 13
Percent	Dollars per acre				
4.125	26.76	1.57	38.09	79.08	6.56
5.75	10.39	.73	12.78	62.86	5.89
7	1.95	.16	2.25	52.90	5.42
8	-3.00	-.27	-3.34	46.21	5.07
10	-9.71	-1.03	-10.30	35.51	4.43
18	-18.42	-3.34	-18.55	13.58	2.60

* Prices used are $6 per cord for pulpwood and $50 per thousand board feet Scribner Scale.

Appendix Table 16. SITE INDEX 60, 35 YEAR ROTATION: Present and annual equivalent values for a single rotation, capitalized values, present values at age 13 years, and annual equivalent value year 13, dollars per acre, for planted loblolly pine timber stands in the Yazoo-Little Tallahatchie Watershed at six discount rates.*

Discount rates	Present value single rotation	Annual equivalent	Capitalized value	Present value at age 13 years	Annual Equivalent year 13
Percent	Dollars per acre				
4.125	28.76	1.57	38.00	82.47	5.77
5.75	10.35	.69	12.05	62.78	5.10
7	1.28	.10	1.41	51.28	4.64
8	-3.88	-.33	-4.17	43.83	4.30
10	-10.61	-1.10	-11.00	32.42	3.70
18	-18.68	-3.37	-18.73	11.38	2.10

* Prices used are $6 per cord for pulpwood and $50 per thousand board feet Scribner Scale.

Appendix Table 17. SITE INDEX 60, 40 YEAR ROTATION: Present and annual equivalent values for a single rotation, capitalized values, present values at age 13 years, and annual equivalent value year 13, dollars per acre, for planted loblolly pine timber stands in the Yazoo-Little Tallahatchie Watershed at six discount rates.*

Discount rates	Present value : single rotation	Annual equivalent	Capitalized value	Present value : at age 13 years	Annual Equivalent year 13
Percent			Dollars per acre		
4.125	28.94	1.49	36.11	82.78	5.14
5.75	9.47	.61	10.61	60.97	4.50
7	.24	.02	.26	48.77	4.07
8	-4.89	-.41	-5.12	41.11	3.76
10	-11.38	-1.16	-11.63	29.77	3.22
18	-18.81	-3.39	-18.83	10.26	1.87

* Prices used are $6 per cord for pulpwood and $50 per thousand board feet Scribner Scale.

Appendix Table 18. SITE INDEX 70, 20 YEAR ROTATION: Present and annual equivalent values for a single rotation, capitalized values, present values at age 13 years, and annual equivalent value year 13, dollars per acre, for planted loblolly pine timber stands in the Yazoo-Little Tallahatchie Watershed at six discount rates.*

Discount rates	Present value single rotation	Annual equivalent	Capitalized value	Present value at age 13 years	Annual Equivalent year 13
Percent	Dollars per acre				
4.125	33.47	2.49	60.36	90.43	15.14
5.75	19.23	1.64	28.56	81.14	14.41
7	11.01	1.04	14.85	74.73	13.87
8	5.75	.59	7.32	70.02	13.45
10	-2.16	-.25	-2.54	61.58	12.65
18	-15.62	-2.92	-16.21	37.67	9.88

* Prices used are $6 per cord for pulpwood and $50 per thousand board feet Scribner Scale.

Appendix Table 19. SITE INDEX 70, 25 YEAR ROTATION: Present and annual equivalent values for a single rotation, capitalized values, present values at age 13 years, and annual equivalent value year 13, dollars per acre, for planted loblolly pine timber stands in the Yazoo-Little Tallahatchie Watershed at six discount rates.*

Discount rates	Present value single rotation	Annual equivalent	Capitalized value	Present value at age 13 years	Annual Equivalent year 13
Percent	Dollars per acre				
4.125	41.82	2.71	65.76	104.56	11.22
5.75	22.37	1.71	29.72	87.64	10.31
7	11.82	1.01	14.49	76.69	9.66
8	5.38	.50	6.30	69.02	9.16
10	-3.75	-.41	-4.13	56.11	8.23
18	-17.02	-3.11	-17.29	25.67	5.36

* Prices used are $6 per cord for pulpwood and $50 per thousand board feet Scribner Scale.

Appendix Table 20. SITE INDEX 70, 30 YEAR ROTATION: Present and annual equivalent values for a single rotation, capitalized values, present values at age 13 years, and annual equivalent value year 13, dollars per acre, for planted loblolly pine timber stands in the Yazoo-Little Tallahatchie Watershed at six discount rates.*

Discount rates	Present value single rotation	Annual equivalent	Capitalized value	Present value at age 13 years	Annual Equivalent year 13
Percent	Dollars per acre				
4.125	45.59	2.68	64.89	110.93	9.21
5.75	22.67	1.60	27.88	88.27	8.27
7	10.86	.87	12.50	74.36	7.62
8	3.90	.35	4.33	65.00	7.13
10	-5.51	-.58	-5.84	50.03	6.24
18	-17.76	-3.22	-17.88	19.29	3.69

* Prices used are $6 per cord for pulpwood and $50 per thousand board feet Scribner Scale.

Appendix Table 21. SITE INDEX 70, 35 YEAR ROTATION: Present and annual equivalent values for a single rotation, capitalized values, present values at age 13 years, and annual equivalent value year 13, dollars per acre, for planted loblolly pine timber stands in the Yazoo-Little Tallahatchie Watershed at six discount rates.*

Discount rates	Present value single rotation	Annual equivalent	Capitalized value	Present value at age 13 years	Annual Equivalent year 13
Percent	Dollars per acre				
4.125	46.91	2.56	61.97	113.17	7.92
5.75	21.73	1.46	25.31	86.32	7.01
7	9.31	.72	10.27	70.63	6.39
8	2.23	.19	2.39	60.46	5.93
10	-7.00	-.73	-7.26	44.86	5.11
18	-18.14	-3.28	-18.20	15.98	2.95

* Prices used are $6 per cord for pulpwood and $50 per thousand board feet Scribner Scale.

Appendix Table 22. SITE INDEX 70, 40 YEAR ROTATION: Present and annual equivalent values for a single rotation, capitalized values, present values at age 13 years, and annual equivalent value year 13, dollars per acre, for planted loblolly pine timber stands in the Yazoo-Little Tallahatchie Watershed at six discount rates.*

Discount rates	Present value single rotation	Annual equivalent	Capitalized value	Present value at age 13 years	Annual Equivalent year 13
Percent			Dollars per acre		
4.125	47.93	2.47	59.80	114.88	7.13
5.75	20.92	1.35	23.42	84.63	6.25
7	8.11	.61	8.69	67.75	5.65
8	1.00	.08	1.06	57.13	5.22
10	-7.99	-.82	-8.17	41.45	4.49
18	-18.32	-3.30	-18.34	14.47	2.63

* Prices used are $6 per cord for pulpwood and $50 per thousand board feet Scribner Scale.

Appendix Table 23. SITE INDEX 80, 20 YEAR ROTATION: Present and annual equivalent values for a single rotation, capitalized values, present values at age 13 years, and annual equivalent value year 13, dollars per acre, for planted loblolly pine timber stands in the Yazoo-Little Tallahatchie Watershed at six discount rates.*

Discount rates	Present value single rotation	Annual equivalent	Capitalized value	Present value at age 13 years	Annual Equivalent year 13
Percent	Dollars per acre				
4.125	42.03	3.13	75.80	104.91	17.56
5.75	25.86	2.21	38.41	94.85	16.84
7	16.48	1.56	22.22	87.90	16.31
8	10.44	1.06	13.29	82.78	15.90
10	1.31	.15	1.54	73.58	15.11
18	-14.50	-2.71	-15.05	47.31	12.41

* Prices used are $6 per cord for pulpwood and $50 per thousand board feet Scribner Scale.

Appendix Table 24. SITE INDEX 80, 25 YEAR ROTATION: Present and annual equivalent values for a single rotation, capitalized values, present values at age 13 years, and annual equivalent value year 13, dollars per acre, for planted loblolly pine timber stands in the Yazoo-Little Tallahatchie Watershed at six discount rates.*

Discount rates	Present value single rotation	Annual equivalent	Capitalized value	Present value at age 13 years	Annual Equivalent year 13
Percent	Dollars per acre				
4.125	57.11	3.70	89.80	130.42	14.00
5.75	33.82	2.58	44.92	111.32	13.10
7	21.03	1.80	25.78	98.88	12.45
8	13.13	1.23	15.38	90.11	11.96
10	1.80	.20	1.98	75.26	11.05
18	-15.43	-2.82	-15.68	39.33	8.21

* Prices used are $6 per cord for pulpwood and $50 per thousand board feet Scribner Scale.

Appendix Table 25. SITE INDEX 80, 30 YEAR ROTATION: Present and annual equivalent values for a single rotation, capitalized values, present values at age 13 years, and annual equivalent value year 13, dollars per acre, for planted loblolly pine timber stands in the Yazoo-Little Tallahatchie Watershed at six discount rates.*

Discount rates	Present value single rotation	Annual equivalent	Capitalized value	Present value at age 13 years	Annual Equivalent year 13
Percent	Dollars per acre				
4.125	67.80	3.98	96.50	148.49	12.32
5.75	38.46	2.72	47.30	120.91	11.33
7	23.10	1.86	26.60	103.88	10.64
8	13.96	1.24	15.50	92.35	10.12
10	1.36	.14	1.44	73.74	9.19
18	-16.01	-2.90	-16.12	34.29	6.57

* Prices used are $6 per cord for pulpwood and $50 per thousand board feet Scribner Scale.

Appendix Table 26. SITE INDEX 80, 35 YEAR ROTATION: Present and annual equivalent values for a single rotation, capitalized values, present values at age 13 years, and annual equivalent value year 13, dollars per acre, for planted loblolly pine timber stands in the Yazoo-Little Tallahatchie Watershed at six discount rates.*

Discount rates	Present value single rotation	Annual equivalent	Capitalized value	Present value at age 13 years	Annual Equivalent year 13
Percent	Dollars per acre				
4.125	71.03	3.87	93.83	153.96	10.78
5.75	38.44	2.57	44.76	120.88	9.82
7	22.07	1.70	24.35	101.39	9.17
8	12.59	1.08	13.51	88.65	8.69
10	-.04	-.00	-.04	68.91	7.86
18	-16.41	-2.96	-16.46	30.84	5.70

* Prices used are $6 per cord for pulpwood and $50 per thousand board feet Scribner Scale.

Appendix Table 27. SITE INDEX 80, 40 YEAR ROTATION: Present and annual equivalent values for a single rotation, capitalized values, present values at age 13 years, and annual equivalent value year 13, dollars per acre, for planted loblolly pine timber stands in the Yazoo-Little Tallahatchie Watershed at six discount rates.*

Discount rates	Present value single rotation	Annual equivalent	Capitalized value	Present value at age 13 years	Annual Equivalent year 13
Percent	Dollars per acre				
4.125	112.11	5.77	139.88	223.44	13.88
5.75	59.05	3.80	66.12	163.52	12.07
7	34.20	2.57	36.64	130.60	10.90
8	20.51	1.72	21.50	110.18	10.08
10	3.32	.34	3.39	80.50	8.71
18	-16.34	-2.94	-16.36	31.48	5.73

* Prices used are $6 per cord for pulpwood and $50 per thousand board feet Scribner Scale.

Appendix Table 28. SITE INDEX 90, 20 YEAR ROTATION: Present and annual equivalent values for a single rotation, capitalized values, present values at age 13 years, and annual equivalent value year 13, dollars per acre, for planted loblolly pine timber stands in the Yazoo-Little Tallahatchie Watershed at six discount rates.*

Discount rates	Present value single rotation	Annual equivalent	Capitalized value	Present value at age 13 years	Annual Equivalent year 13
Percent	Dollars per acre				
4.125	58.34	4.34	105.22	132.50	22.18
5.75	38.00	3.24	56.45	119.96	21.30
7	26.19	2.47	35.31	111.30	20.65
8	18.58	1.89	23.65	104.91	20.15
10	7.07	.83	8.30	93.44	19.19
18	-12.95	-2.42	-13.44	60.61	15.90

* Prices used are $6 per cord for pulpwood and $50 per thousand board feet Scribner Scale.

Appendix Table 29. SITE INDEX 90, 25 YEAR ROTATION: Present and annual equivalent values for a single rotation, capitalized values, present values at age 13 years, and annual equivalent value year 13, dollars per acre, for planted loblolly pine timber stands in the Yazoo-Little Tallahatchie Watershed at six discount rates.*

Discount rates	Present value single rotation	Annual equivalent	Capitalized value	Present value at age 13 years	Annual Equivalent year 13
Percent	Dollars per acre				
4.125	84.53	5.48	132.91	176.78	18.97
5.75	53.03	4.05	70.44	151.06	17.77
7	35.73	3.07	43.80	134.30	16.91
8	25.04	2.35	29.32	122.49	16.25
10	9.68	1.07	10.67	102.47	15.04
18	-13.72	-2.51	-13.94	54.01	11.27

* Prices used are $6 per cord for pulpwood and $50 per thousand board feet Scribner Scale.

Appendix Table 30. SITE INDEX 90, 30 YEAR ROTATION: Present and annual equivalent values for a single rotation, capitalized values, present values at age 13 years, and annual equivalent value year 13, dollars per acre, for planted loblolly pine timber stands in the Yazoo-Little Tallahatchie Watershed at six discount rates.*

Discount rates	Present value single rotation	Annual equivalent	Capitalized value	Present value at age 13 years	Annual Equivalent year 13
Percent	Dollars per acre				
4.125	93.40	5.48	132.94	191.79	15.92
5.75	55.53	3.93	68.30	156.24	14.65
7	35.73	2.88	41.14	134.31	13.76
8	23.94	2.13	26.58	119.49	13.10
10	7.70	.82	8.16	95.62	11.92
18	-14.75	-2.67	-14.85	45.16	8.65

* Prices used are $6 per cord for pulpwood and $50 per thousand board feet Scribner Scale.

Appendix Table 31. SITE INDEX 90, 35 YEAR ROTATION: Present and annual equivalent values for a single rotation, capitalized values, present values at age 13 years, and annual equivalent value year 13, dollars per acre, for planted loblolly pine timber stands in the Yazoo-Little Tallahatchie Watershed at six discount rates.*

Discount rates	Present value single rotation	Annual equivalent	Capitalized value	Present value at age 13 years	Annual Equivalent year 13
Percent	Dollars per acre				
4.125	96.58	5.26	127.58	197.17	13.81
5.75	54.80	3.67	63.82	154.72	12.57
7	33.86	2.62	37.36	129.79	11.73
8	21.75	1.87	23.32	113.53	11.13
10	5.61	.58	5.82	88.42	10.08
18	-15.31	-2.76	-15.36	40.33	7.46

* Prices used are $6 per cord for pulpwood and $50 per thousand board feet Scribner Scale.

Appendix Table 32. SITE INDEX 90, 40 YEAR ROTATION: Present and annual equivalent values for a single rotation, capitalized values, present values at age 13 years, and annual equivalent value year 13, dollars per acre, for planted loblolly pine timber stands in the Yazoo-Little Tallahatchie Watershed at six discount rates.*

Discount rates	Present value single rotation	Annual equivalent	Capitalized value	Present value at age 13 years	Annual Equivalent year 13
Percent	Dollars per acre				
4.125	198.09	10.20	247.15	368.85	22.91
5.75	107.48	6.92	120.34	263.69	19.46
7	65.79	4.93	70.50	206.74	17.25
8	43.18	3.62	45.27	171.83	15.71
10	15.32	1.57	15.67	121.94	13.20
18	-14.89	-2.68	-14.91	43.92	8.00

* Prices used are $6 per cord for pulpwood and $50 per thousand board feet Scribner Scale.

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Summary of Methods for

Johnsongrass Control in Soybeans in Mississippi

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A SUMMARY OF METHODS FOR JOHNSONGRASS CONTROL IN SOYBEANS IN MISSISSIPPI

C. G. McWHORTER[1]

ohnsongrass (**Sorghum halepense** (L.) s.) is one of the most troublesome ds in soybean production in sissippi. This grass is difficult to trol because it produces large quan- s of seed and rhizomes. Johnsongrass luces several million seed annually in vily infested soybean fields. In our bean research plots at Stoneville up to ons of rhizomes/acre were produced. ohnsongrass has been shown to reduce bean yields nearly 50 percent. The pose of this report is to summarize the st effective practices for controlling nsongrass in soybeans in Mississippi. n understanding of the johnsongrass wth habit is necessary to obtain the t control with many of the practices ilable.

Growth Habit

ohnsongrass produces hard seed which l live in the soil for many years before minating. A field in which john- grass has reached maturity for several rs will have a tremendous supply of d. Seed begin to germinate in March or ril and continue to emerge throughout growing season. Seedling plants ally begin to develop rhizomes within 3 weeks after emergence. Reinfestation m seed is especially troublesome in ded areas where each overflow may ng in new seeds. Seedlings continually sent serious problems in these areas n if established johnsongrass is ef- tively controlled.

n addition to its spread by seed, john- grass reproduces vegetatively by ans of rhizomes. Production of these lerground stems is most rapid after dhead development. After heading, a gle johnsongrass plant may produce 200 00 linear feet of rhizomes in one month. hough rhizome production begins 3 or 4 eks after emergence, they develop slowly until plants reach the heading stage.

Many of the rhizomes produced early in the growing season (May or June) will die during the winter, but those produced later in the season usually survive to produce plants the following spring. Small rhizome fragments with a single bud may sprout to produce a new plant. Johnsongrass is also propagated by older above-ground stems. The buds that occur on nodes of stems at least 4-to 6-weeks old will sprout when plowed into the moist soil.

Johnsongrass thrives best on fertile, well-drained soil. If moisture and nutrients are not limiting, rhizomes will penetrate deeper in porous soils than in compact clays. At Stoneville, approximately 80 percent of the johnsongrass rhizomes produced in clay were in the top 3 inches of soil whereas in sandy loam they were in the upper 5 inches. Our research has also shown that soil incorporation of recommended[2, 3] rates of the herbicides a,a,a,-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine (trifluralin) and 4-(methylsulfonyl) - 2, 6-dinitro-N,N-dipropylaniline (nitralin) retard growth from johnsongrass rhizomes in addition to controlling seedlings (Figure 1). Thus, it is

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[2]All references to recommendations are those described in **Weed Control Recommendations** for Mississippi, 1972. A Report by the Mississippi Weed Science Committee, Mississippi State University, Agricultural and Forestry Experiment Station, State College, Mississippi

[3]All agricultural chemicals recommended for use in this report have been registered by the Environmental Protection Agency. They should be applied in accordance with the directions on the manufacturer's label as registered under the Federal Insecticide, Fungicide, and Rodenticide Act

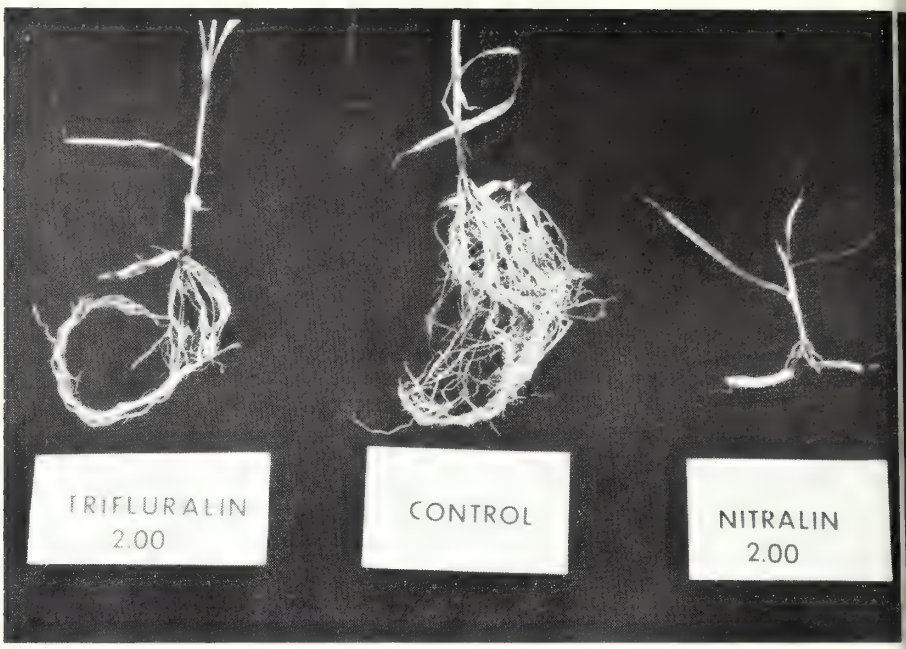

Figure 1. Inhibition of johnsongrass roots from rhizomes by trifluralin (on the left) and nitralin (on the right) as compared to an untreated plant in the center. Both herbicides were applied in nutrient solution to pots of sand in which rhizomes were planted. The rate applied, 2 ppm, was approximately equal to 1 lb-A applied in a field of sandy loam soil. Nitralin was more toxic than trifluralin in this experiment but both often provide equal johnsongrass control in the field.

important that these herbicides be incorporated uniformly to a depth of 3 to 4 inches to be in contact with most of the rhizomes in the soil profile.

Plants from rhizomes emerge more uniformly and from deeper depths in sandy soil than in clay. More plants are obtained from rhizomes cut into small sections than from long rhizomes. Cultural practices that break rhizomes are important in assuring more uniform emergence of johnsongrass for subsequent control either with herbicides or with cultural practices. Increased germination of buds on short rhizomes can be important in a control program because foliar-applied herbicides do not translocate in quantities toxic to dormant (ungerminated) rhizome buds.

Cultural Control

Mechanical cultivation during the growing season often provides the best control for large infested areas of johnsongrass. Cultivation is most successful in months with least precipitation—July to October. Moldboard plows, disk plows, and field cultivators with flat sweeps are used for fallow plowing although disks are used most frequently. Fields should be cultivated every 7 to 14 days to remove top growth and to expose rhizomes to drying. Alternate usage of field cultivators and disk cultivators is slightly more effective than the repeated use of either implement alone. Disking cuts rhizomes into smaller pieces which increases dehydration; field cultivators with sweeps tend to bring more

izomes to the soil surface which also creases dehydration.

Temperatures at the soil surface in mid-mmer often reach 120 to 140°F. In our search, rhizomes exposed at 140°F for 24 urs were killed. Rhizomes exposed at 0° were killed in three days. Rhizomes 2 4 inches long were killed more quickly an were rhizomes 8 to 10 inches long. hus, cultural practices that break izomes into smaller pieces and bring em to the soil surface are most effective a fallow program.

Regardless of the method of fallow, elds should usually be cultivated at 2-eek intervals, but the grass should not be llowed to reach a height of more than 12 16 inches or to produce seedheads. A isadvantage of summer fallow is the loss f a cropping season. This can be partially ffset by production of a small grain crop uring the winter preceding fallow lowing. Small grain production before allowing with cultivation is highly ef-ective and more economical than fallow ithout grain production.

Intensive fallow in early season permits oybean production after a brief fallow eriod. Six to 10 diskings in a 4- to 6- week eriod in the spring will control rhizome ohnsongrass effectively. Approximately wo disk cultivations per week in a 4- to 6-veek period in April and May often rovide good to excellent control of hizomes. This method would be im-ractical if heavy rainfall occurred during his period. Intensive fallow is also im-ractical on many farms because the eaviest demand for tractors and equipment for other farming operations ccurs in April and May.

Johnsongrass rhizomes may also be controlled with flooding. Best results are obtained when fields are covered with 3 to 4 inches of water before johnsongrass rhizomes germinate in early spring. It is necessary to keep water over the infested area for 3 to 6 weeks during the period that johnsongrass normally germinates. Two to 3 weeks of flooding in mid-summer is even more effective although this is usually impractical.

Pasturing has long been recognized as a method of controlling johnsongrass but effective control from pasturing usually requires two or more seasons. Close grazing for two or more years makes johnsongrass plants weak or stunted and causes rhizomes to be formed near the soil surface.

Johnsongrass rhizomes are killed after exposure to freezing temperatures for a few hours. Cultural practices that bring rhizomes to the soil surface for increased exposure provide johnsongrass control in the fall and winter. Continuous cultivation throughout the winter is particularly effective in controlling johnsongrass although most fields are usually too wet to support ground equipment in the winter.

Control with Herbicides

Preplanting treatment with chemicals. Only two chemicals, 1,1'-dimethyl-4,4'-bipyridinium ion (paraquat) and 2,2-dichloropropionic acid (dalapon), are recommended[2] for use in soybean production in Mississippi after johnsongrass has emerged but before soybeans are planted (Table 1). Paraquat at 0.5 to 1.0 lb-A is applied as a broadcast spray to wet all johnsongrass foliage. Paraquat is effective in destroying top growth, but johnsongrass will quickly initiate new growth under optimum growing conditions. As a result, johnsongrass control with paraquat is temporary and control may last no more than 2 or 3 weeks unless repeated applications are made.

Foliar treatment with dalapon at 3.7 to 5.5 lb A is the most effective treatment available for controlling regrowth from rhizomes. Dalapon is applied in water as a broadcast spray to wet johnsongrass foliage. The area treated with dalapon should be thoroughly disked or plowed after 3 days to remove all top growth. Soybeans should not be planted for 5 additional days. If the soil is unusually dry after cultivation, a longer waiting period is needed before planting soybeans. Many

farmers have obtained poor control from dalapon primarily because it was applied under environmental conditions that were not satisfactory for rapid johnsongrass growth. To be effective, dalapon must translocate from the leaves to the rhizomes. Maximum dalapon translocation does not occur unless johnsongrass is actively growing at the time of treatment. Droughty or excessively wet soil, prolonged cloudy periods, or air temperatures below 60°F are not satisfactory for obtaining good results from the use of dalapon.

The arsenical herbicides, disodium methanearsonate (DSMA) and monosodium methanearsonate (MSMA), should not be used in a soybean production program. **The use of these chemicals is n registered for application in soybeans. addition, their usage probably will res in increased arsenic content in soybe seed. Preemergence treatment wi chemicals.** Regardless of the preplanti method used to control johnsongrass, herbicide for preemergence applicati should always be used to control seedli johnsongrass. Little value will be obtain even from complete eradication of joh songrass rhizomes if seedling joh songrass is not controlled. Seedlin produce new rhizomes within a few week

Of the seven herbicides recommende for preemergence use in soybeans Mississippi, trifluralin, nitralin, and chloro-2', 6'-diethyl -N -(methoxymethy

Table 1. Common, trade, and chemical names of herbicides recommended for johnsongrass control in soybeans by the Mississippi Weed Science Committee.

Common name	Trade name[a]	Chemical name
Herbicides for application to soil:		
Alachlor	Lasso	2'-chloro-2,6-diethyl-N-methoxymethylacetanilide
Trifluralin	Treflan	α,α,α,-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine
Nitralin	Planavin	4-(methylsulfonyl)-2,6-dinitro-N,N-dipropylaniline
Herbicides for application to foliage:		
Dalapon	Basfapon or Dowpon	2,2-dichloropropionic acid
Herbicidal naphtha	Several trade names	Petroleum naphtha
Paraquat	Paraquat	1,1'-dimethyl-4,4'-bipyridinium ion
TCA ester	Glytac	ethylene glycol bis (trichloro=acetate)

[a] Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the U. S. Department of Agricultur or the Mississippi Agricultural and Forestry Experiment Station, and it does not imply approval to the exclusion of other products that may also be suitable.

etanilide (alachlor) are most effective
· seedling johnsongrass control (Table
Trifluralin or nitralin at 0.5 to 1.0 lb / A
ay be applied from several weeks before
anting to immediately before planting
· control of seedling weeds. Both her-
ides should be incorporated into the soil
ter application. Trifluralin is also
commended at a higher rate, 1.0 to 2.0
/ A, for the control of johnsongrass from
izomes. These treatments control
nsongrass by inhibiting reproduction of
izomes so usage over a two-year period
important in obtaining adequate control
igure 2).

Alachlor at 1.5 to 3.0 lb / A is applied to
e soil surface at planting or immediately
er planting. Optimum control with
chlor is usually obtained when rainfall
curs within 10 days after application.

Postemergence treatment with chemicals. Of the eight chemicals recommended[2] for postemergence use in Mississippi, only herbicidal naphtha is effective for control of seedling johnsongrass. The first application of herbicidal naphtha (8 gal on a 16-inch band centered on the row) should be made no sooner than 12 days after soybeans emerge. A second application may be applied after 5 days. Johnsongrass from rhizomes will be top-killed by naphtha if treated in early stages of emergence but regrowth usually occurs.

Seedling johnsongrass is effectively controlled by rotary hoeing when weeds are breaking through a slightly crusted soil. Little control is obtained from rotary hoeing on a damp or wet soil.

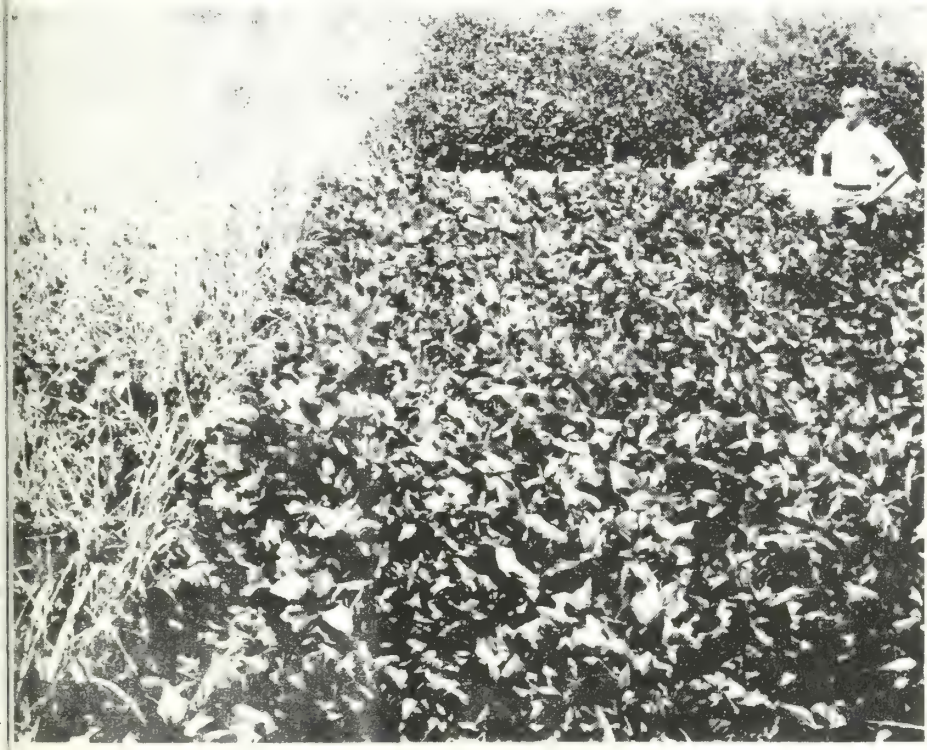

Figure 2. Excellent johnsongrass control in soybeans after 3 annual applications of fluralin at 1.5 lb-a on a Dundee silty clay loam. The herbicide was applied 2 to 3 weeks before anting and double disking was used for incorporation. The area on the left is an untreated ntrol.

Johnsongrass that escapes previous treatment may be controlled with spot treatment of herbicidal naphtha or ethylene glycol bis (trichloroacetate) (TCA ester). These are applied with a tractor or hand sprayer. Treatment with either material is most effective on young johnsongrass. Spot sprays of both herbicidal naphtha and TCA ester are toxic to soybeans and sprays should not be applied to crop plants. TCA ester should not be applied in soybean fields after soybean seed pods have formed. Spot treatment is seldom economical when the level of johnsongrass infestation exceeds 5 percent.

Johnsongrass control in noncropland. Several soil sterilants are recommended[2] by the Mississippi Weed Science Committee that are effective for johnsongrass control in noncropland. These will normally provide johnsongrass control for one to five years depending on soil texture and rainfall after treatment. Application in the fall and early spring provides best control. Use of soil sterilants is beneficial in a total farm program to control johnsongrass because seed produced in adjacent noncropland reinfests soybean fields.

Discussion

A uniform and continuous stand of soybean plants is needed for maximum johnsongrass control regardless of the practices used for control. Research Stoneville has shown that 12 soybe plants / ft of drill are more competitive weeds than reduced soybean stands. T selection of the soybean variety is a important. In research trials, Bragg a Semmes varieties consistently yield higher than other varieties where wee presented moderate to severe competiti The Mississippi Weed Science Committ recommends[2] their use in fields where will not be possible to provide adequa johnsongrass control. There would be yield advantage from the use of these compared to other well-adapted varie in situations where it is known th johnsongrass will be controlled. Ea maturing varieties such as Hill should be planted in fields with a moderate severe johnsongrass infestation.

A large number of practices a available for johnsongrass control soybeans but this weed can rarely exterminated within 1 to 2 years rega less of the methods used (Figure Excellent control is possible, howev within a 2 to 4 year period if rhizo production is eliminated for 1 to 2 ye and if seedlings are not permitted become established. The expense requir to exterminate johnsongrass is more th offset by increased yields and by t savings from reductions in the lab requirements normally expended struggle with johnsongrass each year.

1972 Crop and Fertilizer Recommendations For Mississippi

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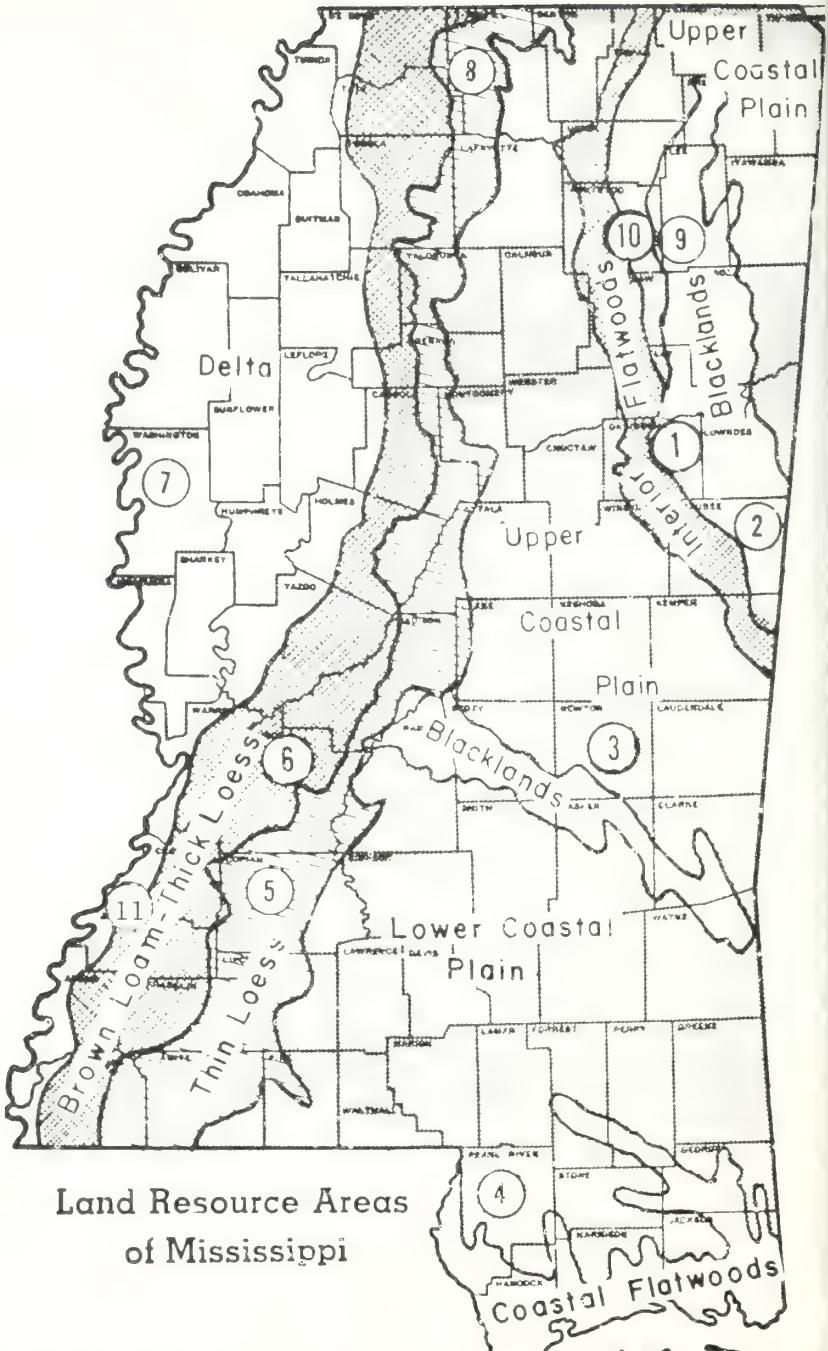

Land Resource Areas of Mississippi

This map shows land resource areas of the state and how Experiment locations fit into them. Number 1 is the main station at State College. Branch s are: 2 Brooksville, 3 Newton, 4 Poplarville, 5 Crystal Springs, 6 Raymond, 7 Stone Holly Springs, 9 Verona, 10 Pontotoc, and 11 Alcorn.

CROP AND FERTILIZER RECOMMENDATIONS FOR MISSISSIPPI

op and fertilizer recommendations made annually by the Mississippi cultural and Forestry Experiment on. These recommendations inorate the latest research findings at College and the Branch Experiment ons. Included is information on ties and fertilization and seeding tices for crops commonly grown in the , as well as information on lawns and turf areas.

cause of varying soil and weather itions and other local factors, no e crop variety or fertilizer recomdation will fit the entire state perly; nonetheless, these general mmendations are useful guides for production. Of course these recomdations assume that other good farg practices will be followed.

more specific information is needed, it be obtained from the Extension ice, the Experiment Station, your nty Agent, or other trained cultural workers in your locality.

Soil Testing Service

he farmer gets maximum profit from lizer only when the right kind and unt are used on each field.

rough the Soil Testing Department of Cooperative Extension Service every ner can get this information as well as rmation on liming practices. Furmore, the Soil Testing Service makes mmendations for exceptionally high luction goals which may not be ided for in the general recomdations.

il testing is a free service. Soil sample s, mailing cartons, and instructions collecting samples are available in county agent's office and the offices her agricultural agencies.

Plant Nutrients

ant nutrients can be divided into two ps: (1) Those elements used by crops relatively large amounts, the ronutrients; and (2) those needed in very small amounts. the micronutrients.

The first group includes nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur. These are usually subdivided into the primary fertilizer nutrients — nitrogen, phosphorus, and potassium — and the secondary fertilizer nutrients — calcium, magnesium, and sulfur. The primary nutrients are applied to crops either as materials or as mixed fertilizers. A fertilizer material usually contains only one fertilizer nutrient. Some examples of fertilizer materials are listed below:

Material	Total Nitrogen N
Ammonium nitrate	34 percent
Anhydrous Ammonia	82 percent
Nitrate of soda	16 percent
	Available Phosphate (P_2O_5)
Superphosphate	18 to 20 percent
	Available Potash (K_2O)
Muriate of potash	60 percent

Mixed fertilizers contain two or more of the fertilizer nutrients. Each fertilizer bag is labeled with a set of numbers to show how much of each nutrient it contains. The first number shows the percentage of nitrogen (N), the second percentage available phosphate (P_2O_5), and the third the percentage water-soluble potash (K_2O). One hundred pounds of a 5-10-10 fertilizer thus contains 5 lbs. of total N:, 10 lbs. of available P_2O_5, and 10 lbs. of available K_2O. Fertilizer ratio refers to the relative amounts of these nutrients. The fertilizer grade gives the guaranteed amounts of each fertilizer nutrient as a percentage. For example 8-8-8 and 10-10-10

are two different grades in a 1-1-1 ratio. Similarly, 6-8-8 and 9-12-12 are two grades in a 3-4-4 ratio. Materials such as ordinary superphosphate may be labeled as 0-20-0.

At present fertilizer nutrients are either expressed as the oxide, phosphorus as phosphorus pentoxide (P_2O_5), or as the element, nitrogen as N, but there is a trend toward expressing all fertilizer nutrients on the elemental basis. Accordingly, phosphate would be expressed as (P) and potash as (K) by using the chemical symbols for phosphorus and potassium, respectively. The primary "fertilizer nutrients' expressed on the elemental basis would then be shown as N-P-K on the fertilizer bag. Some fertilizers are labeled both ways to familiarize consumers with the new labeling trend. When labeled on an elemental basis a 10-20-20 ($N\text{-}P_2O_5K_2O$) would become a 10-8.2-16.5 (N-P-K). The conversion factors for potash are: $K_2O \times 0.83 = K$; $K \times 1.21 = K_2O$. The conversion factors for phosphate are: $P_2O_5 \times 0.436 = P$; $P \times 2.29 = P_2O_5$. Only the method of labeling is changed not the plant nutrient value of the fertilizer.

For the most part fertilizer recommendations are given in this bulletin as pounds of N, P_2O_5, and K_2O needed per acre. Usually the farmer will have a choice of more than one fertilizer grade. For example, 48 lbs. N, 48 lbs. P_2O_5, and 48 lbs. K_2O may be supplied with 600 lbs. of 8-8-8 or 400 lbs. of 12-12-12. Since some deviation from the general recommendation does not affect net profit greatly, it is not necessary to apply exactly the amount of N, P_2O_5, or K_2O as indicated.

Both the need for and the presence of the secondary nutrients in fertilizers is variable. Research has shown that sulfur deficiency is likely to occur on soils in the Hill Section when sulfur-free fertilizers are used. Accordingly, sulfur is recommended for crop production in this area especially for cotton and legumes. A convenient and economical way to get the sulfur is to use mixed fertilizers that contain sulfur. Most solid mixed fertilizers sold in Mississippi contain adequate sulfur, but most liquid mixed fertilizers do not unless special provision is made for the addition of sulfur.

Scattered instances of sulfur deficiency have been observed in the Delta Area. These deficiencies have been associated with land leveling and very sandy soils that are low in organic matter. Since mixed fertilizers are less commonly used in this area, other sources of sulfur may be more economical or convenient to apply. Sources of sulfur that may be used include gypsum, elemental sulfur, ammonium sulfate, and ordinary superphosphate.

Calcium and magnesium are usually applied to soils as agricultural limestone, although a major objective of liming is to neutralize soil acidity. A more complete discussion of liming is given elsewhere. On soils needing magnesium but not requiring lime, the addition of a water-soluble source of magnesium to mixed fertilizers is a very convenient method of applying the magnesium.

The second group of nutrients is referred to variously as "trace elements," "minor elements," and 'micronutrients.' They are needed by crops in very small amounts. Included are iron, manganese, zinc, copper, boron, molybdenum and chlorine. Thus far, only three (zinc, boron, and molybdenum) of these have been found to be deficient to an appreciable extent for crop production in Mississippi. These deficiencies have not occurred on all crops and have been restricted almost entirely to the Hill Section. Specific recommendations for micronutrients are given later for crops which need them.

Solid or Liquid Fertilizers

Mixed fertilizers are available in both solid and liquid forms. Liquid fertilizers have given, or would be expected to give excellent results in most cases, but they are no more effective than many, if not most, solid mixed fertilizers.

The inferiority of some solid mixed fertilizers to liquid mixed fertilizers and to other solids can be attributed primarily to the phosphate component of these fertilizers. Only highly water soluble

sphates are, of necessity, used in the nulation of liquid mixed fertilizers, but water solubility as well as other racteristics of the phosphate materials olid mixed fertilizer may vary widely. highly water soluble phosphates are y effective fertilizers but all those of water solubility are not.

olid mixed fertilizers formulated with monium phosphates and non-moniated superphosphate contain a y high percentage of their phosphorus n water-soluble form and are just as ctive as liquid mixed fertilizers. moniation of ordinary and con-trated superphosphates to add nitrogen ing the formulation of mixed fer-ers, which is a common practice, verts some of the highly effective er-soluble mono-calcium phosphate to er-insoluble calcium phosphate some vhich may be somewhat less effective crop production. This is particularly e with ordinary superphosphate (20 cent) because of the formation of an tite-like calcium phosphate, the ntity of which increases progressively n increasing ammoniation. In a sense rock phosphate is formed. Con-uently, mixed fertilizers formulated m highly ammoniated ordinary erphosphate are not as effective as id mixed fertilizer, or other high lity solids. Unfortunately, most of the sphorus in the apatite-like phosphates ned upon ammoniation of ordinary erphosphate is determined to be ailable" by the chemical method rently used for control purposes.

ith the sources of phosphorus com-nly used in the formulation of mixed ilizers in Mississippi farmers are sonably assured of good results if 50 to ercent of the "available" phosphorus lso water-soluble. Some manufacturers e the water-soluble phosphorus content their fertilizers though this is not uired by law

substantial amount of nitrogen in id mixed fertilizers is derived from a and-or ammonium nitrate. As will be icated later nitrogen solutions con-taining either urea or urea and ammonium nitrate have been much less effective for surface application to summer pastures than either solid urea or ammonium nitrate. Therefore, liquid complete fertilizers would not be expected to be as effective for summer pastures as solid complete (NPK) fertilizers.

Soil pH and Liming

Excessive soil acidity and associated factors reduce crop yields. A recent summary of soil test results by the Cooperative Extension Soil Testing Department showed that some 70 percent of the soils tested needed lime for legumes and 40 percent for non-legumes.

The degree of acidity or alkalinity of a soil is expressed by its pH; values below 7.0 indicate an acid soil, above 7.0 an alkaline soil. Soil reaction, or pH, affects the availability of some of the more important plant nutrients in the soil. Phosphate is much less available in very acid soils than in slightly acid to mildly alkaline soils. In very strongly acid soils (pH below 5.0) certain elements such as manganese and aluminum may become available in such quantities as to be toxic to plants. On the other hand micronutrients such as iron, manganese, boron and zinc rapidly become less available as the pH of the soil is increased above 6.0. This is one reason why one must not overlime. Experience has shown that overliming injury in Mississippi is very likely to be associated with deficiencies of boron and zinc. In the case of cotton and legumes, it is very likely to be due to boron deficiency and with corn, and perhaps other grasses, to zinc deficiency.

Soils with a pH of 6.0 to 7.0 are well supplied with lime. If the pH is less than 5.0, the soil is very strongly acid and is extremely deficient in lime. Most non-legumes grow best at soil pH values of 5.5 and above while most legumes do best if the pH is maintained above 6.0. Alfalfa does best at soil pH values above 6.5.

The amount of lime required to raise the pH of the soil to a desired value depends both on the initial pH and the lime holding

capacity of the soil. For soils of Mississippi having a pH of 5.5 or slightly below, the application of 3000 pounds of lime per acre to sandy loam soils, 5000 or 6000 pounds to loam and silt loam soils, and 7000 to 9000 pounds to clay loam and clay soils, respectively, has satisfactorily corrected lime deficiency for legumes. Since about two-thirds of the soils of the state have pH values of 5.5 or above, and 95 percent above 5.0, these rates of lime would bring the pH of most of the soils of the state within the range that is favorable for legumes. However, some soils need more, some less, and some need no lime. Therefore, the best practice is to test the soils for pH and lime requirement and apply lime as needed to maintain the pH within the desired range.

Lime is lost naturally from the soil by crop removal and by leaching. The use of acid forming sources of nitrogen and the turning under of legumes as soil builders accelerates leaching losses. For example, 100 pounds of nitrogen from such sources as ammonium nitrate, anhydrous ammonia and urea will cause the loss of calcium and other bases equal to about 200 pounds of lime. When applied annually at this rate, the loss would amount to one ton of lime every ten years due to fertilizer alone. Because of these losses, soils need to be limed periodically.

Generally, on sandy loam, loam and silt loam soils a maintenance application of 2000 to 3000 pounds of lime per acre once every 5 to 7 years is required for legumes and for non-legumes fertilized with nitrogen as recommended. On clay loam and clay soils less frequent but larger applications are required. Although lime may be needed badly on some soils for non-legumes, the deficiency is not widespread enough to warrant a general recommendation for rates in excess of maintenance requirements for these crops in the absence of a soil test. Areas going into permanent grass sod should receive the initial maintenance application of lime prior to establishment. Subsequent maintenance applications may be applied to the surface.

Except for the dark upland soils ar bottom soils of the Northeast Blac area, maintenance application shou made to soils that have not been during the past 5 to 7 years.

The principal liming materials ava in Mississippi are ground calcic dolomitic limestones, crushed cha marl from Mississippi deposits and slag. Calcic limestones contain ca carbonate while dolomitic limes contain both calcium and magne carbonates. Liming materials Mississippi deposits contain cal carbonate only. Basic slag, a ma containing a minimum of 6 percent and the equivalent of about 60 percent should be used only where both the and phosphate are needed. The cost use as a liming material onl prohibitive.

Research has shown that all of materials are very effective neutralizing soil acidity providing calcic and dolomitic limestones are ground. Particles not passing a 40- (40-holes per linear inch) are not effective in neutralizing soil acidity this reason 90 to 100 percent of calci dolomitic limestones should pass mesh screen and 50 percent a 100- screen. Particle size is not as import the case of chalk because it contains impurity which causes the particl break down within the soil. It mu crushed fine enough, however, t spread uniformly.

Generally, the Delta and Deep Loes areas are abundantly supplied magnesium, therefore, dolomitic lime no advantage in these areas. In the soil areas of the state, how magnesium levels tend to be lower liming material containing conside magnesium, such as dolomitic should be used; particularly in the theast Blacklands.

For best results lime should be n

ughly with the top six to eight inches
e soil. However, depending on the
re of the soil, a maintenance ap-
ion of 1000 to 2000 pounds per acre
be made as a surface application to
anent pastures, or other permanent

When to Fertilize

lowing their application to the soil,
izers become less available to plants.
occurs because they may be lost by
ing and volatilization or be converted
ss available forms within the soil.
gen is both leached and volatilized.
ssium is leached from some soils but
phate is not. But phosphate is changed
ss available forms.

rtilizers may contain nitrate or
onium nitrogen, or both, or other
s (urea and Cyanamide) that are
ged rather rapidly to ammonium
applied to the soil. Nitrate salts
in fertilizers and in soils are highly
le in water and are not retained
nically by the soil. Therefore, they
ain in solution and move freely with
soil water being easily leached from
oot zone, particularly on sandy loam,
and silt loam soils, or other soils
e water percolates readily. Under
r-logged conditions, which are more
y in clay soils, nitrates may be
ged by soil bacteria to gaseous
gen (denitrified) which escapes into
atmosphere. Ammonium nitrogen is
denitrified nor is it easily leached, but
es not persist for long periods. It is
ged (nitrified) by soil bacteria to
te.

nce nitrogenous fertilizers are not held
ils for long periods they are used more
iently for crop production when ap-
d at or near planting time or during the
ving season.

hosphate fertilizers are not lost by
hing because they react with certain
constituents to become only sparingly
ble in water. In acid soils the reaction
ostly with iron and aluminum but in
tral and alkaline soils calcium
sphates of very low water solubility
also are formed. The soil-phosphate reaction products themselves become less available with time but the process is more rapid in acid soils, particularly at pH values below 6.0.

The formation in soils of sparingly soluble phosphates and their subsequent reduction in availability to plants collectively is referred to as "phosphate fixation." Because of fixation, greater efficiency generally is obtained from annual, seasonal applications of phosphate fertilizer than from less frequent or off-season applications, especially on moderately to strongly acid soils. Accordingly, it is usually suggested that phosphate fertilizers be applied at or just prior to planting, or near the beginning of the growing period for perennial crops.

Unlike phosphate, the effectiveness of potash fertilizers is not reduced appreciably by fixation in Mississippi soils. But there is some loss by leaching, particularly from the more sandy soils. Where leaching is significant annual, seasonal applications result in more efficient utilization of potash than less frequent or off-season applications. Because of uptake in excess of need and its removal in the harvested crop, annual and sometimes split applications of potash are necessary for optimum efficiency for forage crops.

Because of rising costs and labor shortages, farmers increasingly are more interested in greater mechanization, custom services, and in spreading their work load to increase efficiency. One way of spreading the work load is to increase land preparation and application of fertilizers in the fall where feasible for spring-seeded crops.

Fall application of nitrogen for spring-seeded crops is not practical in Mississippi but there are opportunities for fall application of phosphate and potash where fall plowing is practiced. Because of previous fertilization or native fertility, levels of available phosphate and potash in much of our good crop land now are at the point where only small increases in yield, if any, are obtained each year from the application of these fertilizers. At these

fertility levels, which a soil test will show, no more than maintenance rates are needed for maximum economic returns from fertilizer. Under such conditions the crop yield is affected only slightly, if at all, by the time or method of application of the fertilizer. Here there is an opportunity for fall application of phosphate and potash in connection with fall plowing.

Fall application of phosphate and potash need not be restricted to conditions where maintenance rates are required. On slightly acid to Alkaline clay and clay loam soils of the Blackland Area that are very deficient in phosphorus, fall application of phosphate has been just as effective as spring application. Similar results would be expected on other soils having similar native pH values. Top yields also can result from fall application of phosphate or other soils that are low in available phosphorus; but, because of fixation, a higher rate would be needed in the fall than in the spring, especially on acid soils having a pH below 6.0. Eventually, though, the phosphate would build up in these very deficient soils to the point that a maintenance rate would be sufficient either for fall or spring application.

Except for leaching losses, potash applied in the fall for spring-seeded crops would be expected to be about as effective as that applied in the spring. Leaching losses are not particularly significant on clay and clay loam soils. But, as indicated before, leaching losses do occur on the lighter soils. Leaching losses are reduced by broadcasting the fertilizer and maintaining the soil pH above 6.0 by liming. With broadcast application on properly limed soils, substantial losses by leaching probably would not occur except on light sandy soils. Potash losses by leaching can be compensated by higher rates of application which might be an acceptable alternative to spring application in some cases

How to Fertilize

To obtain maximum utilization of fertilizers, the two components of availability, namely chemical and positional, must be optimized c currently. Chemical availability refers the capacity of the fertilizer and its s reaction products to supply nutrients plants. Positional availability refers to location of the fertilizer with respect to plant roots. For example, fertilizer pla in the soil a foot or so from the row positionally unavailable to seedling plar

The chemical availability of nitrog and potassium in fertilizers usually is affected greatly by degree of contact wi the soil. However, the effectiveness highly reactive phosphates is protected reducing their contact with the soil wh slows the rate of phosphate fixation. T may be done either by band placement the soil or by granulation of the fertilizer the factory. Since most solid fertiliz sold in Mississippi are granulated pelletized, method of application has greater effect on positional than chemical availability

To assure effective position availability fertilizers should be placed as to be intercepted by plant roots at appropriate time, or be moved to pla roots with soil water. As plants grow a extend their roots both horizonally a vertically the volume of soil from whi nutrients may be absorbed is increas Consequently, fertilizers that a positionally unavailable during early pla growth may be available later.

Phosphate does not move appreciably soils and the movement of potash somewhat limited, especially on soils medium to fine texture. Therefore, the fertilizers must be placed so as to be tercepted by plant roots. For drill-seed and row crops they should be placed in t soil deep enough to be in the moist s where plants feed as they grow. For su crops, surface application or shallow corporation, as by disking, would be pected to give inferior results because poor positional availability.

Nitrogen as nitrate moves with the so water to plant roots. Its over-all efficien is not affected greatly by degree of co centration or its location within the ro zone except that enough nitrogen should

tionally available for good growth of ng plants

itrogenous fertilizers applied to the ace of dry soils remain positionally vailable for the most part until olved and moved down into the root e by percolating water. Before am- ium nitrogen in fertilizers is moved n into the root zone, it must be changed rified) by soil bacteria to nitrate, a cess requiring two to four weeks for pletion in moist soil during warm sons. Unfavorable positional ilability is avoided by applying ogenous fertilizers far enough in ad- ce of the necessary transformation and vement into the root zone by rainfall to ur by the time the nitrogen is needed by crop.

ocalized concentration of immobile ilizer nutrients, such as phosphorus potassium, near the row or drill, as ults from band application, provides a y favorable opportunity for early in- eption by plant roots as well as for ensive root development within the ilized zone later, a condition which tributes to optimum fertilizer ef- ency. An outstanding benefit from sphorus is its favorable influence on early growth and development of nts. This effect is enhanced by localized cement of fertilizer near the row.

lthough maximum efficiency of sphate and potash is usually obtained band placement for row crop and drill- ded crops, top yields can be obtained h broadcast application of these fer- zers. But on soils that are low to very in phosphate and potash, higher rates needed for broadcast than for band lication to obtain the same increase in ld. This is especially true where the ilizer is incorporated by shallow king instead of being plowed under.

ecause of accumulation from previous lications, only a small percentage of row-crop land previously cropped to ton and fertilized as recommended over ng period would be expected to be so in phosphate and potash as to require appreciable increase in the recommended rate to obtain essentially the same yields when broadcast as when banded beside the row.

A hazard of localized placement of the fertilizers near the row is salt injury to seeds and seedlings resulting in poor stands and stunted growth. Since fertilizer salts, such as nitrates and chlorides, move mostly upward and downward with soil water rather than laterally by diffusion, salt injury can be avoided by placing the fertilizer to the side of rather than beneath the seed. The distance of separation required depends upon the kind of fertilizer and the rate of application. For recommended rates of phosphate and potash and up to about 40 pounds of nitrogen per acre, the minimum distance of separation should be 3 to 4 inches to the side of and 3 to 4 inches below the seed. With higher rates of nitrogen or potash both the horizontal and vertical distances between seed and fertilizer should be increased, or the fertilizer should be broadcast and plowed under.

Surface application of phosphate and potash to sod crops is more effective than for row crops. This is due in part to the development and persistence of plant roots near the surface. Because it is both convenient and effective this method of application is recommended for maintenance fertilizers on perennial, close-growing crops.

Solid sources of nitrogen are much more effective for surface application to summer pastures than are the urea-ammonium nitrate solutions such as N-Sol-32 and uran. These solutions have ranged in effectiveness from 66 to 74 percent of that of solid ammonium nitrate. Urea solid has been equal to ammonium nitrate when applied in June, but when applied a month earlier its relative value was about 85 percent of that of ammonium nitrate.

Foliar Feeding

Plants absorb and utilize nutrients applied in solution to their leaves and if a deficiency exists, yields and-or quality may be improved by foliar application. Because they are required in such small

amounts, very dilute nutrient salt solutions of the micronutrient (trace elements) may be used quite satisfactorily as foliar sprays to correct deficiencies without injury (burning) to foliage. In some areas foliar feeding of trace elements has become a somewhat standard practice for crop production. Frequently, micronutrients are applied conveniently and inexpensively along with insecticides and fungicides. A typical example is the application of boron to cotton with the insecticide. However, so far, under Mississippi conditions there appears to be no need for both foliar and soil application of micronutrients where they are needed for crop production.

The primary (nitrogen, phosphorus, and potassium) and the secondary (sulfur, calcium, and magnesium) nutrients, absorbed in relatively large quantities crops. Thus, to supply a substantial pa the total requirement of these nutri without burning the leaves of plants w require several applications of ra dilute solutions during the growing sea Therefore, foliar feeding of these nutri is not as feasible as foliar feeding of micronutrients. Increases in the yiel cotton have been obtained in Mississi under certain conditions from fo feeding of the primary nutrients, but it not been shown so far to be a desirabl economical alternative to soil applica of these nutrients. Therefore, fol feeding is not now recommended routir in lieu of or as a supplement to soil plication of primary plant nutrients.

Recommendations for Major Field Crops

Corn

Hybrid: Detailed results of hybrid corn trials are published annually in Mississippi Farm Research. Ample seed of hybrids with N-cytoplasm (resistant to Southern Corn Leaf Blight) should be available for 1972 planting. Seed sold in 1972 will be labeled as to type of cytoplasm and only N-cytoplasm hybrids should be grown.

Seeding Dates and Rates and Land Selection: Plant in North Mississippi from April 1 to April 25, in North Central Mississippi from March 25 to April 20, in South Central Mississippi from March 15 to April 15, and in South Mississippi from February 25 to March 15.

Corn should be planted on deep to moderately deep soil with fair to good surface drainage. Steep, droughty, and eroded hillsides are not well suited to corn.

Stands should be adjusted to yield and generally should be within the range of 12,000 to 18,000 plants for average yields of 80 to 100 bushels per acre, increasing with the yield. A good rule of thumb is to provide approximately 150 plants for each bushel of corn. Thus, on land that will produce an average yield of 80 bushels the stand should be 12,000 plants per acre, 100 bushels 15,000 plants, and for bushels 18,000 plants. On land well adap to corn, yields usually will fall within range of 80 to 120 bushels per acre un good cultural practices. However, aver yield goals in excess of 100 bushels acre generally should not be set unl supplemental irrigation is available.

Fertilization—Hill and Delta Foot Areas: Soils of the Hill and Delta—Foot Area generally require a complete tilizer for corn. Soils should be limed maintain the pH above 5.5. Occasiona following the application of lime, z deficiency may be encountered, especia on soils of medium to coarse texture. W this occurs, a mixed fertilizer wh contains enough zinc to give 2-3 pounds acre should be used for two to three ye No other micronutrient deficiencies h been observed in corn.

Time: Apply all of the phosphate potash before planting. Nitrogen may applied before planting or in split plications: one-fourth to one-third bef planting and the remainder as a s dressing by the time the corn is knee hi

ate: Apply 120 to 250 pounds of nitrogen
t 40 to 70 pounds each of phosphate
O_5) and potash (K_2O) in ap-
ximately 3-1-1 ratio, but adjust the rate
he expected average yield. For an
ected yield of 120 bushels per acre the
is 210 lbs. N, 70 lbs. P_2O_5, 70 lbs. K_2O.
lower yields the rate is reduced
portionately, being 162 lbs. N, 54 lbs.
O_5 54 lbs. K_2O per acre for a 100-bushel
d and 120 lbs. N, 40 lbs. P_2O_5 40 K_2O for
of 80 bushels. If corn is grown con-
uously for silage for several years,
ly 50 to 60 lbs. of phosphate and 100 to
pounds of potash per acre in a 1:2 ratio.

lethod: All of the phosphate and potash
up to 40 pounds of nitrogen per acre
y be placed in a band located 3 to 4
nes to one side and 3 to 4 inches below
seed. The remaining nitrogen may be
led at least 6 inches from the row,
adcast, or applied later as a side
ssing. All or part of the nitrogen may be
adcast as a mixture with phosphate
l potash, however, the fertilizer should
plowed down as should all broadcast
lications of phosphate and potash.
plant applications of anhydrous am-
nia should be placed at least 6 inches to
side of and 6 inches below the seed.

lace side-dress applications of nitrogen
ot or more from the row, nonpressure
utions and solid sources at a depth of 4
hes and anhydrous ammonia at a depth
inches. Surface, sidedress, application
solid sources and nonpressure solutions
lmost as effective as in-soil placement.

ertilization—Delta Area: For soils in
s area, only nitrogen is needed
nerally for top production. Soil test for
sphate and potash needs.

ime: Nitrogen may be applied just
or to planting or in split application:
e-half at or before planting and the rest
a side-dressing before the corn is knee
h.

ate: 120 to 250 pounds of nitrogen per
re, increasing the rate as the expected
ld increases.

lethod: Place preplant applications of
rogen 6 or more inches from the drill row, non-pressure solutions and solid sources at a depth of 4 or more inches and anhydrous ammonia at a depth of 6 inches below the level of the seed. Side dress applications of nitrogen should be placed 1 foot or more from the row, non-pressure solution and solid at a depth of 4 inches and anhydrous ammonia at a depth of 6 inches. Surface application of solid sources and non-pressure solutions is only slightly less effective than in-soil placement.

COTTON IN THE DELTA

Varieties: Results of variety tests are published annually in Mississippi Farm Research.

Seeding Dates and Rates: Plant as soon after April 1, as weather permits, but not in cold soil. Hill dropped—16 to 22 pounds of delinted seed per acre. Drilled—30 to 40 pounds of delinted seed per acre. Drilled for cross plowing—60 pounds of delinted seed per acre. Seed should be of good viability.

Fertilization: Delta soils generally need only nitrogen for most profitable yields but deficiencies of phosphate and potash do occur occasionally. This is especially true for potash on sandy loam and silt loam soils of the Eastern Delta and Foothill Area. Therefore, soils should be tested for phosphate and potash needs. Also, sandy soils that are low in organic matter or that have been leveled should be tested for sulfur needs.

Time: Apply nitrogen in the spring at or prior to planting, except on sandy loam soils having very good to excessive internal drainage and on clayey soils with poor surface drainage. On such soils, split application of nitrogen should be made, one-half at or prior to planting and the rest as a side dressing preferably by mid-June. Split application of nitrogen on clays with poor surface drainage is recommended because of possible loss of nitrogen by denitrification during wet periods.

Rate: On sandy loam, loam, and silt loam soils rates from 90 to 100 pounds of nitrogen per acre are recommended for solid planted cotton and for all skiprow

patterns. One hundred to 120 pounds of nitrogen per acre is recommended for the silty clay loam, silty clay, and clays regardless of the planting pattern, except that for clays with poor surface drainage the rate should be 120 to 150 pounds of nitrogen per acre.

For cotton following soybeans or pasture sod, the nitrogen rate should be reduced 20 to 30 and 40 to 50 pounds per acre, respectively.

On soils where stalk growth is too rank, maturity too late, and boll rot is a problem because of excess nitrogen, the nitrogen rate should be reduced by 30 percent.

All nitrogen fertilizer recommendations are on the basis of a planted acre regardless of the planting pattern, that is, whether skiprow or solid.

Method: Same as for Delta Area corn.

COTTON IN HILL AREAS

Varieties: Results of variety tests are published annually in Mississippi Farm Research.

Seeding Dates and Rates: Plant between April 10 and May 10 as weather permits. Hill dropped — use 16 to 22 pounds of well delinted seed or 12 to 16 pounds of acid delinted seed per acre. Drilled — use 20 to 30 pounds of well delinted seed or 15-20 pounds of acid delinted seed per acre. All seed planted should be of good quality.

Fertilization: A complete fertilizer (NPK) containing sulfur and boron is needed in the Hill Sections. Fertilizers for the dark upland soils of the Northeast Blackland Area having a pH above 6.0 should contain enough water-soluble magnesium to supply at least one-half and preferably as much magnesia (MgO) as potash. On soils more acid than pH 6.0 magnesium deficiency may be corrected by applying dolomitic lime at the rate of one to two tons per acre, or as indicated by a soil test.

Enough boron is provided when the mixed fertilizer contains boron and phosphate in the proportion of 0.3 pounds to 48, respectively, or a boron to phosphate ratio of 1:160. No more than 0.5 pounds [water-soluble boron should be drilled w the fertilizer.

Acid soils should be limed according soil tests to maintain the pH above 5.

Time: Apply the phosphate and pot and all or part of the nitrogen at or a weeks before planting time. On deep san or sandy loam soils with very good excessive internal drainage, side-dr one-half to two-thirds of the nitrogen most effective results. Make side-dr applications of nitrogen by mid-June week or more earlier if anhydrous a monia is used), or at early square f mation.

Phosphate and potash may be applied the fall under certain conditions—s section on When to Fertilize.

Rate: Apply 72 pounds of nitrogen and 48 pounds each phosphate (P_2O_5) a potash (K_2O) per acre except as follow Increase the nitrogen to 120 pounds and t phosphate and potash to 60 pounds ea per acre on the dark upland soils of t Blackland Areas, and increase t nitrogen to 90 pounds per acre on the we drained bottom and on the level to gent sloping upland soils of the Upper Coast Plain. Excessive stalk growth and delay maturity indicate too much nitroge Somewhat stunted growth associated wi yellowish green foliage and the ear yellowing and premature shedding of t leaves indicate too little nitrogen. Wh these conditions are observed nitrog rates should be adjusted accordingly.

Where a skip row planting pattern followed the rate of nitrogen per plante acre should be the same as is recon mended for solid cotton but the rate phosphate and potash should be increase to 60 pounds of each per acre where lower rate is recommended for soli cotton. In a 4 x 4 or 2 x 2 planting patter there is, of course, only one-half acre planted cotton.

Method: Same as for corn in Hill ar Delta Foot Hill Areas. Contact placeme of seed and fertilizer or placement direc ly beneath seed should be avoided.

the phosphate and potash are applied
dcast, the rate should be increased to
unds of each per acre on soils known
somewhat low in these nutrients. A
test will indicate such conditions.
ever, as indicated before an increase
te generally will not be required on
previously cropped to cotton and
lized as recommended. If a
mergence herbicide is to be broadcast
worked into the soil, phosphate and
sh applied broadcast should be plowed
before the herbicide is applied.

SOYBEANS

rieties: Delta, Hill Section and
ral Mississippi—Hill, Dare, Davis,
Lee 68, Pickett 71, Semmes and Bragg
ed in order of maturity.)
uth of U.S. Highway 84—Bragg,
pton 266A, Hardee, Pickett 71 on cyst
matode-infested land.

ils: Soybeans are adapted to all Delta
and to most soils of the Hill area, but
r yields may be expected on droughty
such as eroded and shallow upland

eding Dates and Rates: May 1 to June
cept extreme South Mississippi May
June 20. Plant 40-50 pounds of good
per acre.

oculation: If not on land where a crop
ell nodulated soybeans has grown
n the last five years, the seed should
noculated.

rtilization — Delta Area: Soybeans
ire no fertilizer on most Delta soils but
gh percentage need lime. A soil test
indicate the need for lime as well as
phate and potash.
the Eastern Delta and Foothills Area
olybdenum seed treatment is needed
top yields on all soils that were
iously acid regardless of current lime
s, and elsewhere in the Delta on soils
g a pH below 6.0. A seed treatment of
. of sodium molybdate per acre, or its
valent is recommended.

rtilization — Hill Area: In the Hill
, phosphate and potash as well as lime usually are needed. Except for the dark soils of the Blackland Area of Northeast Mississippi, some 70 percent of the soils of the Hill Area need lime for top yield. In the absence of a soil test, apply both phosphate (P_2O_5) and potash (K_2O) in a 0-1-1 ratio at the rate of 40 to 50 pounds per acre. The fertilizer may be banded or broadcast. If broadcast, it should be plowed-in instead of disked-in for best results. If banded the fertilizer should be placed 3 to 4 inches below the seed. Avoid contact placement with the seed as well as band placement directly beneath the seed. Much newly cleared land, as well as land in unfertilized pastures, is extremely deficient in phosphorus and the rates indicated above probably will not be adequate for most profitable yields if this land is planted to soybeans. On such land the phosphate should be increased to 80 pounds per acre for a few years by using a mixed fertilizer of 0-4-3 ratio.

In some parts of the state double cropping of small grain and soybeans may be practiced. In such a system it would be satisfactory to apply all of the phosphate and potash recommended for both crops to the small grain but they should be broadcast and worked into the soil.

In the Hill areas a seed treatment of $^1/_2$ oz. of sodium molybdate per acre, or its equivalent, is recommended on all soils and especially on soils having a pH below 6.0.

Because of injury to the bacterial culture, the inoculant and sodium molybdate or other soluble molybdate or other soluble molybdenum salts, should not be premixed for more than 24 hours before being applied to seed beans that are planted immediately following treatment. Actually, the best practice is to apply the inoculation and molybdate salt separately and then mix both with the beans in the same operation.

RICE IN THE DELTA

Varieties: Long Grain: Bluebonnet 50, Starbonnet, Dawn, and Bluebelle which mature in 150, 142, 130 and 115 days respectively. Medium Grain: Nova 66 and

Vista which mature in 125-130 days.

Seeding Dates and Rates: Rice can be seeded from mid-April to mid-June depending upon variety. The very early varieties should not be planted until June. Seeding rate 90 to 110 pounds if drilled and 110 to 135 pounds if broadcast or water seeded.

Fertilization: Apply from 100 to 140 pounds of nitrogen per acre on old crop land. New land will probably require no nitrogen for the first one or two years. The ammonium forms of nitrogen such as ammonium sulfate and urea are recommended. Fertilizer may be applied before seeding if covered by approximately 2 inches of soil. Otherwise, it may be applied just before the first flood or one-half before the first flood and one-half at the correct "joint stage." This stage occurs when the first internode or distance between the lowest two joints is ¾ inch for very early varieties, ¼ inch for Starbonnet and 1½ inches for other varieties. If all the nitrogen is applied before the first flood, do not drain the field but maintain a continuous flood for the entire season.

SORGHUMS FOR GRAIN, SILAGE

Varieties for Grains: DeKalb BR 64, RS 700 and Acco 1093 are bird-resistant varieties with good yield potential which have the best resistance to anthracnose disease. Anthracnose infection is unpredictable and may vary in severity from year to year. The following bird-resistant hybrids will yield well if anthracnose does not develop: Funks BR 79, Penngrain BR, GA 615, Funks BR 630, McNair 546, Asgrow Brasvis R, DeKalb BR 64, AKS 614, Taylor-Evans Bird-a-Boo, Acco R 1023, FMC Shoo Bird, AKS 663 and RS 700 and Acco 1093.

Bird-resistant varieties may be used for high energy silage, but these varieties may cause palatability problems especially when fed to milk cows in high production. Non-bird resistant varieties such as Funks G 522, DeKalb E 57 and RS 610 may be damaged by birds, but are much more desirable for a high quality silage. The resistance to weathering found in bird-resistance is not as important when the grain is harvested for silage i a slightly immature stage.

Varieties for Silage: FSIA, FS24, NK 10 Lindsey 102F.

Seeding Dates and Rates: April 2 t July 15. Earlier dates are preferred first harvest is made by July 25, a sec cutting can usually be made if m moisture is adequate. Seed 5 to 7 lbs o seed per acre in rows.

Fertilization: For comparable yields i soil fertility and fertilizer requirement o grain sorghum and corn are quite simi However, grain sorghum usually does o yield as well as corn under conditions n favorable to production of both. (sequently, the average fertili requirement is not as high as for cor

For Grain: In the Delta Area (nitrogen is needed generally. Depen upon the average yield, apply 80 to pounds of N per acre, the lower rate average yields of 60 to 70 bushels per a and the higher rate for average yield 100 to 120 bushels per acre. For termediate yields, intermediate rates nitrogen are recommended.

In the Hill Areas phosphate and pot as well as nitrogen generally are requi For average yields 50 to 60 bushels acre, apply 60 to 75 pounds of nitrogen and 30 to 40 pounds each of phosph (P_2O_5) and potash (K_2O) per acre. average yields of 90 to 100 bushels per a 100 to 130 pounds of N and 50 to 60 pou each of P_2O_5 and K_2O.

Where a stubble crop is desired, ap an additional 40 to 60 pounds of nitro after the first crop.

Depending on soil productivity, aver yields can be expected to range from 5 90 bushels per acre for early planti where proper cultural and fertiliza practices are followed. Average yie from late plantings (after July 1) woul considerably lower.

Sidedress applications of nitro should be made by the time six leaves showing which normally occurs before sorghum is ten inches high.

For Silage: Apply as for grain, exc

ole the rate of potash.

ethod of Application: Same as for

1.

SUGARCANE FOR SYRUP

arieties: C. P. 36-111 and C. P. 67-500.

leep, well drained soils of light texture.

eding Dates and Rates: Cut seed cane e top mature joint and at ground level, do not strip before planting. Plant in Fall (October 15) at the rate of 2 stalks, is, place stalks end to end with a whole k at the union. Plant the cane in 4-foot s on land that has been broken 5 to 6 es deep a few weeks earlier. To ect from cold and to provide good nage, cover the cane 6 to 8 inches deep forming a ridge over it so that the nage furrows between the rows are 2 inches deeper than the cane.

ertilization: In the spring apply 40 to 50 nds each of nitrogen and phosphate (P_2O_5) and potash (K_2O) per acre shortly r germination of the eyes or just before rowth from stubble. Place the fer- er in a band so that it will be 4 to 6 es to the side of the row and 3 to 5 in- s deep after the ridges have been ked down, or 1 to 2 inches deeper than cane. Sidedress with about 30 pounds of ogen per acre before July. Place side- ssing nitrogen in the edge of the root e deep enough to be in moist soil out being disturbed by subsequent ivation.

op and cup the cane before freezing ther. Harvesting as much as a month re processing improves syrup quality reduces "sugaring."

GRASSES, LEGUMES, AND SMALL GRAINS

pplementary Information on Pasture ommendations for the Hill Section

lanting: In most instances a grass - me mixture will provide less ex- sive and more nutritious pasture ge than grass alone. Therefore where ctical new pastures should be planted the desired grass plus one or more mes. The pasture should then be ilized to meet the needs of the legume, nely phosphorus, potash and lime as ded. Rates of these nutrients sufficient the legume, will also be adequate for grass. The legume should provide adequate nitrogen for both species through fixation. In general, it is unwise to apply fertilizers containing nitrogen to grass-legume mixtures.

Renovation of Grass-legume pasture: Where the stand of legumes in a pasture has degenerated to less than 15 percent or has been lost entirely, it would pay to reseed legumes. This is best done in the fall season. The pasture should be closely grazed or mowed and the clover seed broadcast or drilled along with a fertilizer containing phosphorus and potash as indicated by soil test (See page 19).

Planting: If equipment is available, drill or band placement of seed and fertilizer is recommended for the establishment of all pasture and forage crops. With small-seeded legumes and grasses, care must be taken not to seed too deep. A seeding depth no more than ½ inch is recommended. Most plantings are made by broadcasting the seeds on the soil surface. It is advisable to cultipack the seed bed immediately before or after seeding.

Fertilization General: For established pastures, solid and liquid complete fertilizers and solid sources of nitrogen may be top-dressed. On summer grass pastures, however, the efficiency of top-dressed urea-ammonium nitrate (non-pressure) solutions has been quite low compared to solid ammonium nitrate.

Because of the wide variety of soils to which these pasture recommendations will be applied, and of the extensive nature of the typical commercial livestock operation in Mississippi, particularly beef cattle, the pasture fertilizer recommendations are generally presented as a range instead of a single and more arbitrary figure.

The lower limit of the recommendation is estimated to be sufficient for plant establishment and (1) for reasonable yields of forage on soils well adapted to the particular pasture crop under consideration, (2) for periods of economic stress during which it is still necessary to maintain a reasonable supply of cheap forage, and (3) where acreage per animal unit is not a serious limiting factor.

The upper limit of the fertilizer recommendations should be used where

the (1) soil type, (2) management system, (3) type of livestock enterprise, and (4) economic trend are such as to justify the considerably higher yields of forage.

Fall application of phosphorus or potash to pastures is recommended if these nutrients are necessary to establish forage seedlings in the fall. However, spring application is slightly more effective for spring and summer growth of perennial plants and those which come up in the spring. In general, fertilizers should be applied as close as practical to the time they are to be used by plants, therefore seasonal, annual applications are indicated in the following tables on forage and pasture crops. If phosphate and potash are applied only once in two years, double the annual application rate.

Fertilization of Grass Pastures: The yield of grass forages is greatly increased by nitrogen fertilization and, where weather conditions do not limit growth, excellent response is obtained to high rates of nitrogen; therefore, the most economical rate will depend upon temperature, availability of moisture, and the use made of the additional forage.

Utilization of Forage: To insure maximum forage profit from fertilizer applied to pastures, livestock producers should add additional animals to fertilized pastures to use additional forage.

Caution: Excessive amounts of nitrogen applied in one application may result in grass tetany or nitrate poisoning.

To increase the utilization of the nitrogen or to obtain a more favorable distribution of pasture production, split applications of nitrogen are recommended for both summer and winter grass pastures, at 60-80 pounds each time.

Except for Coastal bermudagrass, where the last application may be as late as August 15, the last application of nitrogen to permanent summer pastures should be made no later than July 15, and two weeks earlier if anhydrous ammonia is used. Because of the frequency of drought, mid-summer applications of nitrogen are generally less effective than applications made in the spring and early summer,. So, more nitrogen should be applied in the spring than in summe

It may be economical to apply up to pounds of nitrogen per acre to millet sudangrass; 180 pounds to common mudagrass, dallisgrass, and bahiagr and 240 pounds to Coastal bermudag

For summer temporary grazing cr at least 50 percent of the total nitro should be incorporated into the seed with phosphorus and potash prior planting. Use the remainder on the surf after each grazing or cutting.

Fertilization of Grass-legume C binations: Forage legumes may be fectively used to supply nitrogen requi by the associated grasses. When prop used, forage legumes, extend the graz season, increase total forage product increase forage quality and result in be utilization of land resources. The choic legume species and cultural practi should be determined by when the for is needed, availability of seed and pric seed. The application of nitrogen fertili to grass-legume swards will reduce the fixing efficiency of the legumes. Nitro should not be used on permanent gra legume mixtures when legumes make 15 percent or more of the stand.

Caution: Where conditions especially favorable for legumes danger of bloat may prevent full utilizat of legumes seeded alone or of gra legume combinations such as dallisgr and white clover, particularly in the D Loess area. The drilling of small grains ryegrass into such a pasture in No Mississippi orchardgrass will lessen bloat problem and supply additio forage.

For winter growing grass-legu combinations, the legume will supply nitrogen needed by the grass. Howe since grass-legume mixtures sometin "grow off" more slowly than grass al fertilized with nitrogen; it may be visable to plant a portion of the win pasture to grass alone and use nitro fertilizer as recommended in the tabl

Inoculation of Clovers: All seed clovers and other forage legumes sho be inoculated with the proper culture pr to planting. It is imperative that seeds new clovers like Arrowleaf be inoculat

Selection of Varieties: The use of c tified seed will reduce the risk of bring noxious weed seed onto the farm and res in better performance.

Pasture or Hay Crop	Recommended Varieties	Rate of Seeding Per acre	Time of Planting	Fertilization, lbs.-A. Annual Application
Alfalfa	Cody, Delta and Florida 66	15 20 lbs.	Sept.-Nov.	Test soil for lime, Phosphorus, and potash needs.
Bermudagrass	Coastal	20 bu. sprigs	Feb May[1]	150 to 240 lbs. N, 2 3 applications beginning June 1, for grazing, For hay, 300 400 lbs. N.
Bermudagrass White Clover	Regal, Merit, or La. S-1	2 lbs.	Plant Clover Sept. Nov.	Test soil for lime, phosphorus, and potash needs.
Fescue and White Clover	Kentucky 31 Fescue, Regal or La. S-1 White Clover	10 lbs. Fescue 1-2 lbs. Clover	Oct. Nov. Feb. May	Test soil for lime[2], phosphate, and potash needs [2]
Red Clover	Orbit or Kenland	10-15 lbs. seed alone or in small grains	Sept.-Nov.	Test soil for lime, phosphate and potash.
White Clover	Regal, La. S-1, or Merit	2-3 lbs.	Sept. Nov.	Test soil for lime, phosphate and potash.
Arrowleaf Clover	Meechee or Yuchi	12-15 lbs.	Sept. Nov.	Test soil for lime, phosphate and potash.
Sorghum-Sudan hybrids	Commercial Varieties	20 lbs. in rows 35 lbs. broadcast	Apr.-June	60 lbs. N prior to planting. 60 lbs. N after 1st and 2nd cutting.
Korean Lespedeza	Climax or Summit	20-25 lbs. seed in small grains	Feb. Apr.	Test soil for lime, phosphate, and potash.
Oats	Coker 242, Nora, or Florida 501	3 bu. for grazing 2 1/2 bu. for grain	For grazing: early Sept. For grain mid-Oct.	Grazing: 60 lbs. N at planting and 60 lbs. in Feb. Grain: 45 to 60 lbs. N March 1-March 15
Wheat	Arthur 71, Blueboy, Coker 65-20, Coker 68-15 or Wakeland	1 1/4 bu. for grain 1 1/2 bu. for grazing	Same as Oats	Same as Oats.
Rye	Explorer or Elbon	1 1/4 bu. for grain 1 1/2 bu. for grazing	Same as Oats	Same as Oats.
Barley	Harrison or Jefferson	Same as Wheat	Same as Oats	Same as Oats.

[1]If irrigated Coastal may be planted from April 1 to Sept. 1 [2]Where clover disappears in the grass-clover mixtures apply 60 lbs. N in the fall.

RECOMMENDATIONS FOR PASTURES AND FORAGES IN HILL SECTIONS

Pasture or Hay Crop	Recommended Varieties	Time and Planting	Rate of seeding Per Acre	Fertilization, lbs./A Annual Fertilization[1]
ESTABLISHED WARM SEASON GRASSES (PERMANENT)				
Bahiagrass	Pensacola, Wilmington, (Argentine—South Mississippi only)	Feb.-May	15 lbs.-A	120 to 180 lbs. N in split applications and 30 to 45 lbs. each of P_2O_5 and K_2O. Total application in a 4-1-1 ratio.
Bermudagrass	Common	Feb.-May	5 lbs. seed	Same as for Bahiagrass.
	Coastal	Feb.-May If irrigated plant as late as Sept. 1.	20 bu. of sprigs per acre	**For Grazing:** 120 to 240 lbs. N in split applications and 30 to 60 lbs. each of P_2O_5 and K_2O. Total application in 4-1-1 ratio. **For Hay:** 200 to 300 lbs. N in split application; 50 to 90 lbs. of P_2O_5; 100 to 180 lbs. K_2O. Total application in a 4-1-2 ratio.
Dallisgrass	Commercial	Feb.-May	10 lbs. (live seed)	Same as Bahiagrass.
Johnsongrass	Commercial	Feb.-May	15-25 lbs. (live seed)	Same as for Coastal Bermudagrass.
ESTABLISHED COOL SEASON GRASSES (PERMANENT)				
Tall Fescue	Kentucky-31 or Goar	Sept.-Nov.	15 lbs.	80 to 140 lbs. N, split—fall and spring; 40 to 60 lbs. each of P_2O_5 and K_2O in a 1:1 ratio
Orchardgrass (North Miss. only)	Jackson or Boone	Sept.-Nov.	15 lbs.	Same as Tall Fescue

[1]Established stands

Recommendations For Pastures In Hill Sections—(Continued)

Pasture Crop	Recommended varieties	Time of Planting	Seeding Per Acre	Fertilization, lbs./A. Annual Application
WARM SEASON GRASS-LEGUME MIXTURES (PERMANENT)				
Bahiagrass, Bermudagrass Dallisgrass with one of the following legumes.		As before	As before	**Establishment**: 60 to 100 lbs. each of P_2O_5 and K_2O in a 1:1 ratio.
White Clover	Regal, La S 1 Merit	Sept.-Nov.	1 3 lbs.	**Maintenance**: 40 to 60 lbs. each of P_2O_5 and K_2O in a 1:1 ratio.
Crimson Clover	Chief, Autauga or Tibbee	Sept.-Nov.	25 lbs.	Same as above, For seed production add 0.5 to 1 lb. of boron.
Arrowleaf Clover[1] Annual Lespedeza	Meechee or Yuchi Climax, or Summit	Sept.-Nov. Feb.-April	10-15 lbs.	Same as Crimson Clover. **Establishment**: 60 lbs. each of P_2O_5 and K_2O in a 1:1 ratio. **Maintenance**: 40 lbs. each of P_2O_5 and K_2O.
Johnsongrass with one of the following for hay:	Commercial	Feb.-June	15-25 lbs. (live seed)	**Establishment**: 120 to 160 lbs. each of P_2O_5 and K_2O in a 1:1 ratio.
Alfalfa	Florida 66, Delta, or Cody.	Sept.-Nov.	15 lbs.	**Maintenance**: 60 to 80 lbs. P_2O_5 and 180 to 240 lbs. K_2O in a 1:3 ratio plus boron.
Red Clover	Orbit, Kenland or Chesapeak	Sept.-Nov. or March-April on clean land.	10 lbs.	Same as with Alfalfa.
Rough Peas	Commercial, also known as Caley, Singletary, and Wild Winter Peas.	Sept.-Oct.	30 lbs.	60 to 90 lbs. P_2O_5 and 120 to 180 lbs. K_2O in a 1:2 ratio, 120 lbs. N after peas mature.

[1]Specified scarified seed.

WARM SEASON GRASSES (ANNUAL OR TEMPORARY)				
Millet	Gahi 1, Millex, or Pearlex	Apr. June	15 lbs. in rows 35 lbs. broadcast	120-150 lbs. N, split application, 60 lbs. P_2O_5 and 60 lbs. K_2O.
Sorghum-Sudan Hybrids	Commercially available varieties	April June	15 lbs. in rows 35 lbs. broadcast	120 to 180 lbs. N in split applications; 60 lbs. P_2O_5 60 lbs. K_2O.
COOL SEASON GRASS-LEGUME MIXTURES (ANNUAL OR TEMPORARY)				
Annual Ryegrass with one of the following:	Gulf, Magnolia, Blends or (common in North Miss. only)	Sept.-Nov.	25 lbs.	60-100 lbs. each of P_2O_5 and K_2O in a 1:1 ratio at seeding time.
Arrowleaf Clover[1]	Meechee or Yuchi	Sept. Nov.	10 lbs.	
Crimson Clover	Autauga, Chief, or Tibbee	Sept.-Nov.	20 lbs.	Same as above
Annual Ryegrass and wheat or oats with legume (as with ryegrass)	As above	Sept.-Nov.	25 lbs.	Same as above
	See wheat and oats	Sept. Nov.	90 lbs.	
Small Grains and Legume (Use same as with ryegrass	Oats, rye or wheat (See varieties under grass)	Sept.-Nov.	90 lbs. of small grain	Same as above.
COOL SEASON GRASS—LEGUME MIXTURES (PERMANENT)				
Tall Fescue or Orchardgrass (North Mississippi only) with White Clover	Alta, or Kentucky 31	Sept.-Nov.	10 lbs. in 20" rows	**Establishment**: 60 to 100 lbs. each of P_2O_5 and K_2O in a 1:1 ratio. **Maintenance**: 40 to 60 lbs. each of P_2O_5 and K_2O in a 1:1 ratio.
	Commercial, Boone, or Jackson	Sept. Nov.	10 lbs.	
	Regal, Merit or La. S 1	Sept. Nov.	2 3 lbs.	

[1]Specify scarified seed

Recommendations For Pastures In Hill Sections—(Continued)

Pasture Crop	Recommended varieties	Time of Planting	Seeding Per Acre	Fertilization, lbs. A. Annual Application
	ANNUAL COOL SEASON GRASSES AND SMALL GRAINS			
Annual Ryegrass	Gulf, Magnolia, or Florida Rust Resistant, (Common in North Miss. only)	Sept. Oct.	30 40 lbs.	120 to 220 lbs. of N, split fall and spring; 80 to 100 lbs. P_2O_5 and 40 to 50 lbs. K_2O in a 2:1 ratio.
Barley (Grain only)	Dayton, Harrison, Kenbar, Hanover, Barsoy, or Keowee	Oct. Nov.	1½ bu.	10-15 lbs. N, 20 30 lbs. each of P_2O_5 and K_2O, at seeding. Topdress with 40 to 60 lbs. N about March 1.
Oats	Coker 242, Coker 67-22 Forager*, Moregrain 211 Nora, or Sumpter 37	For Forage: Sept.-Oct. For Grain: Oct.-Nov.	For Forage: 128 lbs. (4 bu.) For Grain: 2½ bu.	Same as Ryegrass. Same as Barley.
Rye	Albon, Explorer or Abruzzi-NC	For Forage: Same as Oats For grain Oct.-Nov.	For Forage: 90 lbs. For Grain: 2½ bu.	Same as Ryegrass. Same as Barley.
Wheat	Arthur, Blueboy, Coker 65-20, Coker 68-15 Georgia 1123, Andnox, Wakeland, or Coker 68-15	Same as for Rye	For Forage: 90 lbs. For Grain: 1¼ bu.	Same as Ryegrass. Same as for Barley.

* For Forage only.

LEGUMES

Alfalfa (Hay)	Florida 66, Delta, or Cody	Sept.-Nov.	15-25 lbs.	**Establishment:** 120 to 160 lbs. each of P_2O_5 and K_2O in a 1:1 ratio and 1.5 lbs. boron. **Maintenance:** 60-80 lbs. P_2O_5 and 180 to 240 lbs. K_2O in a 1:3 ratio and add 1 lb. boron
Arrowleaf Clover[3]	Meechee or Yuchi	Sept.-Oct.	10 lbs.	60 lbs. each of P_2O_5 and K_2O in a 1:1 ratio. For seed production add 0.5 to 1.0 lb. boron.
Austrian Winter Peas	Commercial	Sept.-Oct.	50 lbs.	Same as for Arrowleaf Clover.
Crimson Clover	Autauga, Chief, or Tibbee	Sept.-Oct.	20-30 lbs.	Same as for Arrowleaf Clover.
Lespedeza (Annual) Sericea (Perennial)	Climax, or Summit Serala, or Commercial	Feb.-April Feb.-June	25 lbs. 30-40 lbs.	Same as for Arrowleaf Clover.
Red Clover (Hay)	Orbit, Kenland or Chesapeake	Sept.-Nov. Mar.-Apr.	10 lbs.	**Establishment:** 60 to 100 lbs. each of P_2O_5 and K_2O in a 1:1 ratio. **Maintenance:** 50 lbs. P_2O_5 and 100 lbs. K_2O in a 1:2 ratio.
Rough Pea	Commercial—also known as Singletary, Caley and Wild Winter peas.	Sept.-Oct.	40 lbs.	Same as for Arrowleaf Clover.
Vetch	Warrior	Sept.-Oct.	30 lbs.	Same as for Arrowleaf Clover.
White Clover	Regal or Merit	Sept.-Nov.	2-3 lbs.	Same as for Arrowleaf Clover.

[1]For legumes and glass legume combinations, soil should be limed initially to establish and subsequently to maintain a pH of 6.0 to 7.0; for non-legumes the pH range should be 5.5 to 6.5. Refer to section on Soil pH and Liming. Unless indicated otherwise fertilizer recommendations are for grazing. When forage and pasture crops are harvested repeatedly from the same area for hay or silage instead of being grazed, the rate of potash should be about twice that recommended for grazing.

[2]All legume seed should be inoculated with the proper culture immediately before planting.

[3]Specify scarified seed.

RECOMMENDATIONS FOR LAWNS AND SIMILAR TURF AREAS

Grass	Recommended Varieties	Method of Planting	Rate of Planting	Fertilization per 1000 Sq. ft. per Yr.[1]
Bahiagrass	Pensacola or Wilmington	Seed	5-10 lbs./1000 sq. ft.	6 lbs. nitrogen 2 lbs. P_2O_5 4 lbs. K_2O split into 4 applications
Bermudagrass	Common	Seed	2 lbs./1000 sq. ft.	6-8 lbs. nitrogen 2 lbs. P_2O_5 3-4 lbs. K_2O, split into 4 applications
	Tiflawn, Ormond, Tifway or Tifdwarf	Sprig or plug	Sprig or plug 6-12 ins. apart on 6-12 in. rows	
		Stolonize	2-5 bu./1000 sq. ft.	
Carpetgrass	Common	Seed	5 lb./1000 sq. ft.	2-3 lbs. nitrogen 1 lb. P_2O_5 1-2 lbs. K_2O, split into 2-3 applications
Centipedegrass	Common, or Oaklawn	Seed or	4 oz./1000 sq. ft.	Same as carpet
		Sprig or plug	Sprig or plug 6-12 ins. apart on 6-12 in. rows.	
Fescue	K-31,	Seed	7-10 lbs./1000 sq. ft.	4 lbs. nitrogen (2 in fall, 2 in spring) 2 lbs. P_2O_5 and 4 lbs. K_2O
Ryegrass	Gulf, or Magnolia	Overseed permanent lawns	8-10 lb./1000 sq. ft.	1 lb. nitrogen in January if needed
St. Augustinegrass	Common	Sprig or plug	Sprig or plug 6-12 ins. apart on 6-12 in. rows	Same as bahia
Zoysiagrass	Emerald, Matrella, or Meyer	Sprig or plug	Sprig or plug 6 ins. apart on 6 in. rows	Same as bahia

[1/8]When establisning a new lawn incorporate 2-3 lbs. of N; 4-6 lbs. of P_2O_5 and 2-3 lbs. of K_2O per 1000 sq. ft. into the seedbed prior to planting.

lopulation Growth And ledistribution In Mississippi, 1900-1970

By ELLEN S. BRYANT

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Summary of Population Trends

Several current trends and historical facts in Mississippi's population have been underlined in this report.

First, a new high of 2,216,912 in Mississippi's population was reached in 1970. The previous high occurred in 1940 when the total was 2,183,796.

Second, rural population — which was also at a peak in 1940 — has since been steadily declining.

Third, all of the net growth in Mississippi since 1960 is white and urban. During the 1960's, nonwhites lost 278,000 migrants; whites gained nearly 9,000 in-migrants.

The total number of nonwhites declined by 97,000 (less than their migration loss because of offsetting gain through natural increase), while white numbers increased by 136,000 persons during the decade. Over the same period, the state's urban population increased by 166,000 while the rural population lost a net of 127,000.

Fourth, as a result of these changes, Mississippi white-nonwhite proportions have reversed from a 40:60 ratio in 1900 to a 60:40 ratio in 1970. The urban proportion of the population has increased from 7.7. percent in 1900 to 44.5 percent in [illegible] However, compared to the 1970 nati[illegible] urban average of 73.5 percent, Missis[illegible] is still a rural state.

Fifth, in spite of the high rate of lo[illegible] nonwhites from the state population, [illegible] at the county level does not seem t[illegible] related to having a high percent of [illegible] whites. Rather it seems to be related [illegible] lack of urban-industrial growth.

Sixth, ten general areas of urban [illegible] centration have been crystalized out [illegible] earlier dispersed, but relatively de[illegible] rural population. Further crystalizat[illegible] may develop. Urban growth in Mississ[illegible] seems to be moving in the directio[illegible] many dispersed centers of growth [illegible] pattern which many students of popula[illegible] distribution see as a preferred subst[illegible] to the proliferation of supercities.

Seven, there was a general tendenc[illegible] the majority of population centers to g[illegible] regardless of size and regardless [illegible] whether or not surrounding areas [illegible] growing. Seventy-five percent of [illegible] population centers in the state sho[illegible] some increase between 1960 and 1970

POPULATION GROWTH AND REDISTRIBUTION IN MISSISSIPPI, 1900-1970

By ELLEN S. BRYANT *

e continuing urbanization of ssippi's population has seemingly ed a threshold and is now, according 70 Census returns, upsetting long- ing loss trends and creating sizable ributions of population within the

ing the 1960's, for the first time in entury[1], the state experienced a net gition gain of nearly 9,000 white ents; and, for the first time since it recorded a net gain in numbers. ssippi Agricultural and Forestry riment Station studies indicate that ate's population was 2,216,912 in 1970, y 39,000 or 1.8 percent larger than the Census enumeration.

te growth accounted for the entire crease and an additional 100,000 ns. The nonwhite segment of the ation, with a migration loss of 277,000 net loss of about 100,000[2], offset of the white growth and kept the ll increase at the low 1.8 percent.[3] ummary, the nonwhite population ued, and even increased, the pattern y heavy out-migration which began decade of the 1940's; the white ation pattern reversed to a growth , which incorporates both the retention of its natural increase and an in-migration sufficiently large to effect the first over all net increase in the State's total population in 30 years.[4]

Table 1 gives Mississippi population figures by color for Census years since 1900. The total population figures show fluctuating trends with little net change in numbers.

The nonwhite population has had variable, but persistent, losses and is smaller now than it was in 1900. The white population, on the other hand, has grown consistently, although until the last decade the increments were less than the group's natural increases and growth was sizably cut by heavy migration losses.

As Table 1 shows, the consequence of the differential growth trends of the two races is a complete reversal of the white-nonwhite proportions in the state since the beginning of the century. In 1900, nearly 60 percent of Mississippi's people were nonwhite, but in 1970 62 percent were white.

In view of the difference in population trends by color at the state level, direction of population trends by color was compared at the county level. Surprisingly, 68 of Mississippi's 82 counties had similar population trends for both races; either both were growing or both were declining, although rates of change varied considerably.

Urban Trends

Even more significant than the differential growth trends for whites and nonwhites in Mississippi has been the urban growth of the state. While the white population has approximately doubled since the beginning of the century, the urban population has increased eightfold.

Table 2 compares urban and rural growth for the state since 1900. It can be seen that only since 1940 have rural

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stant Sociologist, Mississippi Agricultural and y Experiment Station

Ellen S. Bryant, **Net Migration in Mississippi, 1960**, Bulletin 632 (State College: Mississippi ural Experiment Station 1961, pp. 5 and 9

ural increase (births minus deaths) of 180,000 for offset the high migration loss and kept net loss 00. See **1970 Census of Population and Housing, ppi**, PHC(2)-26 (Washington: U.S. Government Office), May 1971.

white population of Mississippi increased by etween 1960 and 1970. Of this number, 126,147 can buted to natural increase and 8,739 to in- n. See reported cited in Footnote 2

population trends been the consistent inverse of urban trends in the state. Before this, rural growth accompanied urban growth, with the exception of only one decade, and swelled substantially a result of the back-to-the-farm moven that occurred during the Gr Depression.[5]

Table 1. Mississippi Population Trends by Color, 1900 to 1970

Year	POPULATION		
	Total	White	Nonwhit
1970	2,216,912	1,393,283	823,62
1960	2,178,141	1,257,546	920,59
1950	2,178,914	1,188,632	990,28
1940	2,183,796	1,106,327	1,077,46
1930	2,009,821	998,077	1,011,74
1920	1,790,618	853,962	936,65
1910	1,797,114	786,111	1,011,00
1900	1,551,270	641,200	910,07

Source: U. S. Bureau of the Census

Table 2. Urban and Rural Population Trends for Mississippi, 1900 to 1970

Year	POPULATION		
	Total	Urban	Rural
1970	2,216,912	986,642	1,230,270
1960	2,178,141	820,805	1,357,336
1950*	2,178,914	607,162	1,571,752
1940	2,183,796	432,882	1,750,914
1930	2,009,821	338,850	1,670,971
1920	1,790,618	240,121	1,550,497
1910	1,797,114	207,311	1,589,803
1900	1,551,270	120,035	1,431,235

*Change in urban definition.
Source: U. S. Bureau of the Census

Redistribution

redistribution of population into
er areas of higher concentration is
ted by the maps in Figures 1 and 2,
compare the extent of high density
for 1940 and 1970. On these maps,
density areas were designated as
counties where the average
ation per square mile was as high or
r than the state average of 46.1
ns per square mile, which persisted
1940 through 1960.
same definition was used for 1970,
hough the average state density had
en increased to 46.9 persons per
e mile.[6]
year 1940 was a population bench-
for Mississippi in several
ts. Until the recent Census it
d the population peak in the state's
y. It was also the year of peak rural
ation size. And the white-nonwhite
rtions of the population were almost
that year.
1940 map shows a relatively large
er of counties with densities as great
ater than the state average. Thirty-
r nearly 40 percent of the 82 counties
ied as high density areas at this
Most were located in the northern
f the state, clustering both in the
and in the northeast sections.
ulation per square mile in many of
elta counties — such as Sunflower
Coahoma (84.8); and Bolivar (73.7)
as high or higher than the non-Delta
izing counties — for example
n (70.0); Lowndes (69.4); Lee
Lauderdale (80.8); Jones (69.7);
85.4); and Harrison (86.8). The most
y populated county at this time was,
rse, Hinds, with 122.3 persons per
mile. Washington County was
with 92.8.
1950, the pattern was changing.
counties had slipped out of the high-
y class. Panola dropped from just
to just below the state average and
ntinued to decline until, by 1970, it
percent less dense than in 1940.
County declined from its original 46.0 to 42.9 but has since nearly reachieved its original level and seems in the latest decade to be almost holding that level. Holmes began a sharp decline after 1940 and by 1970 had decreased its density by 42 percent, from 52.0 to 30.1 persons per square mile.

During the next decade, 1950 to 1960, the decrease in the number of high-density counties was much greater. In this period Tunica, Tallahatchie, Humphreys, Neshoba, Lincoln, Monroe, Madison, and Prentiss declined to below-average density. Between 1940 and 1970 the first three had decreased by nearly 50 percent; Neshoba had decreased by 25 percent (although it has been holding its own since 1960); Madison by nearly 20 percent; Monroe by close to 10 percent (although it is also holding its own since 1960).

Lincoln's decline has been slow, but continuous, amounting to 5 percent by 1970. Prentiss declined to below-average density in 1960 but, while still 3.8 percent less dense than in 1940, had almost recovered its original density and moved back into the above-average density category by 1970.

In all, 11 of the original 31 high-density counties had moved out of the group by 1960. Only one, Jackson County, which contained a sparse 27.7 persons per square mile in 1940, had joined the high-density group by 1960 with an approximate tripling over the 20-year period. By 1970, it was four times as dense as in 1940. In summary, only 21 counties were classed as high density in 1960.

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[5] Some of the increment occurring between 1940 and 1950 results from a change in the definition of urban population so as to include persons living in built-up, densely populated areas located outside of corporate urban boundaries

[6] The definition of high and low density counties used in this report is both arbitrary and relative. All of Mississippi can be considered sparsely settled. For instance, some estimated average population densities for 1960 are: United States, 50.5; the World, 65.0; Massachusetts, 654.5; California, 100.4; Los Angeles County, California, 1,487.

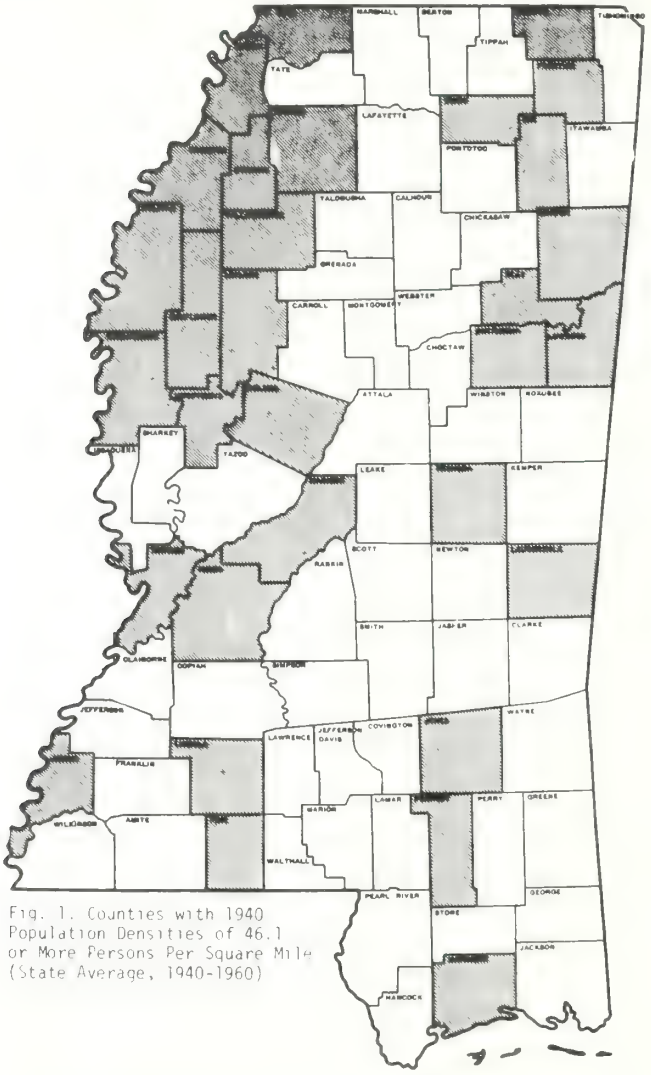

Fig. 1. Counties with 1940 Population Densities of 46.1 or More Persons Per Square Mile (State Average, 1940-1960)

In the last decade, 1960 to 1970, three more counties (Union, Quitman, and Tate) declined to below-average density, but three others moved into the high-density group. Prentiss, as mentioned above, rejoined the group and Rankin and Grenada Counties became new high-density counties. By comparing the maps in Figures 1 and 2, it can be seen that, over the 30-year period, 13 of the original 31 high-density counties (or 42 percent) l their population leads.

Only three others increased th population concentrations to achie above-average densities. Two of these a adjacent to metropolitan counties; one becoming a new nucleus of urban grow

However, in spite of the fact t Mississippi had only 21 as opposed to high- or above-average density counties

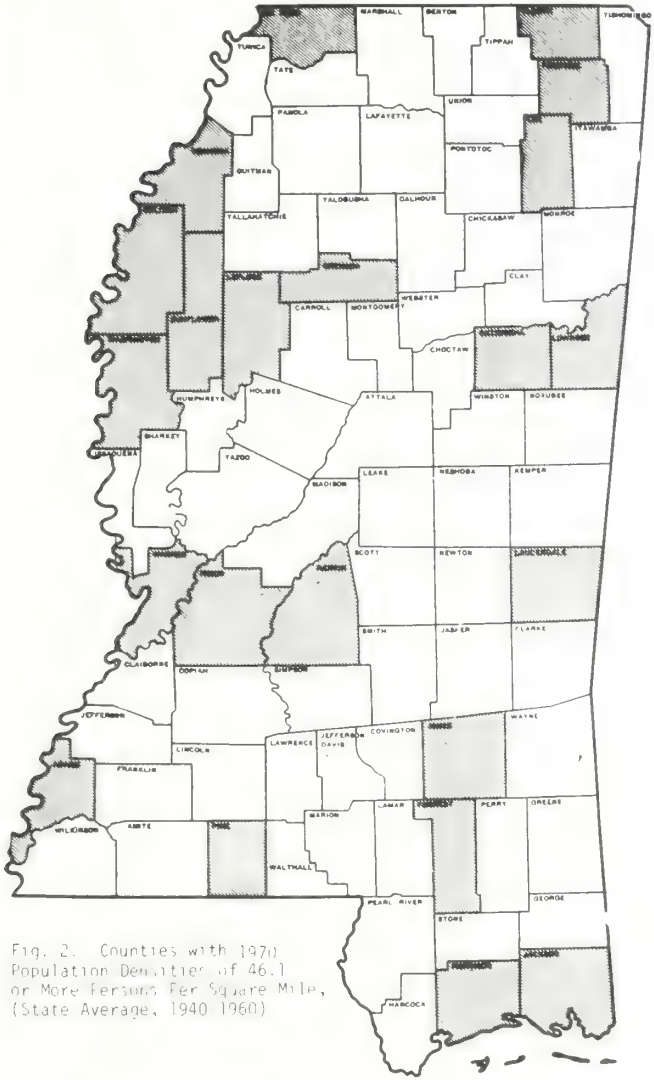

Fig. 2. Counties with 1970 Population Densities of 46.1 or More Persons Per Square Mile, (State Average, 1940-1960)

As compared to 1940, Mississippi's population is larger today than at the earlier date. The explanation lies in the increasing concentrations in fewer counties.

The map in Figure 3 depicts which counties have increased in population density since 1950. Checks indicate growth, dots indicate loss. Large checks and dots signify gains or losses of over 25 percent; small checks and dots signify gains or losses of under 25 percent but over 2.5 percent. Counties with no coded pattern changed less than 2.5 percent during the 20-year period.

Those counties coded as growing either contain, or lie adjacent to, growing urban centers. Rates of increasing density have been very impressive in some counties. In 1940, only one county, Hinds, had more

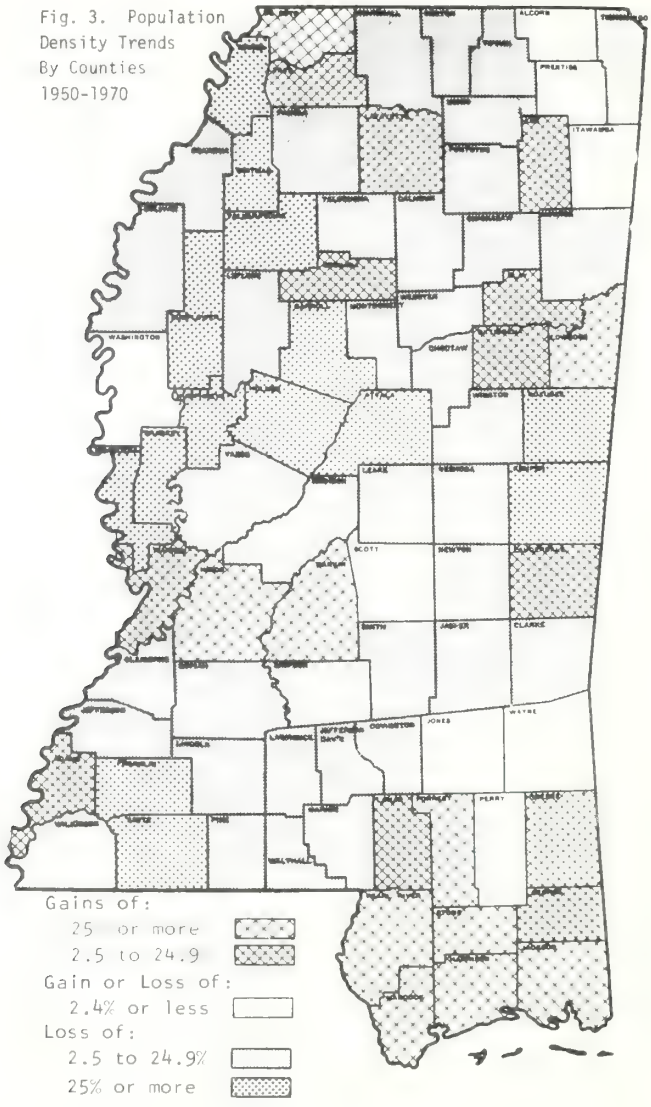

Fig. 3. Population Density Trends By Counties 1950-1970

than 100 persons per square mile; in 1970, five counties did. These were Hinds (245.4); Harrison (230.1); Forrest (123.6); Jackson (119.5); and Lee (101.4). Three others (Lowndes, Washington, and Lauderdale) had more than 90 persons per square mile. Only Washington was in the 90-plus class in 1940. All of these counties contain sizable urban centers. Table 7 gives county data on growth and density by color for 1950, 1960, and 1970.

Regional Differences

gionally, it is the Mississippi Delta has suffered the severest population s in the process of urbanization and ation redistribution. None of the counties has increased in net ation in the last 20 years. However, al are still relatively dense, and renewed or accelerated urban h might easily change the 20-year of decreasing concentration to one of asing concentration. Population y in the Delta has, up to the present been mostly of a rural instead of an nature.

he northeast, the number of high- y counties has been reduced to two of growth out of the earlier more sive density, but these counties have enerally experienced the heavy loss of the Delta counties. The minant pattern in the northeast has for little change or only moderate

ximity to industrializing com- ies and the tendency toward long- ice commuting as a substitute for tion probably explain the minimal es in the northeast. Figure 3 ates the absence of any growing ies in the Delta, and the presence of the northeast. In addition, the Delta nly one stable county while the east has three.

re 3 also indicates the extensive h that has been occurring in the southeast corner of the state. h, in fact, extends into the third tier nties bordering the Gulf of Mexico. e southwest, only Adams shows h.

growth band across the middle of ate includes Jackson and Vicksburg e west and Meridian, in Lauderdale y, on the eastern boundary. Two density areas of growth are in the east—DeSoto County and Grenada y. The first of these is mostly ex- d by the proximity of the Memphis politan area; the second, however, e in the process of becoming a new node of population growth providing urban and industrial services to both rural Delta and rural hill hinterlands.

By comparing the growth and high-density maps, Figures 2 and 3, it can be seen, in summary, that Mississippi, over the past 30 years, has been precipitating a population distribution pattern of ten islands of above-average population density. In or around nine of these areas there has been urban growth and increasing density during the last 20 years. Only in the area of Pike County has there been no recent net growth.

The Delta has been blanketed by loss, with only one county contiguous to the Delta having an increase in population density. As population adjustments to agricultural mechanization in the area continue, islands of urban growth in the Delta will probably become statistically apparent in terms of increased county densities. Sizable urban centers have existed in the Delta for many years.

It appears from Figure 3 that the indicated islands of population growth have been draining population out of the rest of the state. This has undoubtedly been true to some extent. Calvin Beale has found that white population has recently been migrating within the southern region, while blacks have been making long distance moves out of the region.[7]

It is the white population that is responsible for most of the growth in the state, and for all of the net growth. However, it should not be assumed that this has been the only pattern of movement or that it will continue indefinitely into the future. In this era of automobile and highway transportation, population concentrations tend to be more dispersed than in earlier years. Commuting can be substituted for migration,

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[7]See Calvin L. Beale, "Rural Urban Migration of Blacks: Past and Future," **American Journal of Agricultural Economics**, Vol. 53, No. 2 (May 1971), p. 303.

[8]Rufus E. Miles Jr., "Statement on Hearings of the President's Commission on Population Growth and the American Future," **Toward a Population Policy, Population Bulletin**, Vol. 27, No. 3 (June 1971), pp. 25, 31.

Table 3. Distribution of Counties by Growth Pattern and Density Type

Growth Pattern	All Types		DENSITY TYPE*							
			1		2		3		4	
	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
Growing	22	27	10	48	4	27	2	10	6	24
Stable	8	10	3	14	1	7	2	10	2	8
Losing	52	63	8	38	10	66	17	80	17	68
The State	82	100	21	100	15	100	21	100	25	100

*Defined in terms of 1950 Densities. Type 1 = 50.0 or more persons per square mile; type 2 = 40.0 to 49.9; Type 3 = 30.0 to 39.9; Type 4 = under 30.

Table 4. Average Growth Prediction Scores by Growth Pattern and Density Type

Growth Pattern	All Types	DENSITY TYPE*			
		1	2	3	4
Growing	1.23	1.4	1.0	0.5	1.33
Stable	1.25	1.7	1.0	1.0	1.0
Losing	.6	.6	.7	.71	.41
The State	.83	1.14	.8	.71	.68

*See Table 3 for definition.

and many small cities can have industrial growth of their own.

In any case, Mississippi seems to be developing dispersed nuclei of urban growth, a pattern which is hypothesized as a solution preferable to expanding supercities for future population distributions in the nation.[8]

Growth Factors

Inasmuch as the two factors, color and percent urban, seem closely associated with population trends in Mississippi, an effort was made to assess their portance. Growth prediction scores w computed for each county on the bases these characteristics.

Counties were scored 0, 1, or 2 depend on their percent urban and percent wh in 1950. If both these percents were abo the state's average, a county received score of two; if one factor was abo average, the county scored 1; if b percents were below average, the cou scored zero. County scores were th tabulated by density type and grow pattern.

ılts of these classifications and tions may be seen in Tables 3, 4, and ıer classification of density was used he simple above-and below-average n the preceding descriptions. These efined in the footnote to Table 3, gives a simple percent and ncy distribution for counties.

table does show a pronounced ıcy for growth in the highest density es and for loss in the lower density es. But the patterns are mixed.

e 4 gives the Growth Prediction for the same categories of counties. arison of Density Types 1 and 4 in- s that growing counties of both sy levels tended to have above- ge percentages of urban and white tions, while losing counties tended e lower-than-average levels of these teristics. However, the prediction do not seem to have a strong ation with density type.

y of the intermediate categories requencies which are too small to drawing conclusions, but the ssion of scores from one category to xt is not consistent. It is perhaps noting that the highest score was ed by the three counties in the st density and stable growth ry.

nalysis of the relative importance of nd degree of urbanization can be n Table 5, which gives the percent of es in each density-growth class zero on each of these score com- s. Among losing counties, 44 percent zero on both components; only 3.8 t of losing counties (two counties) zero on the color factor only.

owing counties, on the contrary, the t proportions of zero scores are in the color factor. Twenty-seven t of these as opposed to 25 percent of and 3.8 percent of losing counties ro scores on the color factor only. lata suggest that racial composition nly indirectly associated with tion growth in Mississippi counties the period of analysis and that degree of urbanization in 1950 was the primary factor.

The tendency for counties to have parallel growth or loss trends for both whites and nonwhites has already been noted. However, it should be emphasized that trend similarity was more prevalent for losing and for small counties than for large and growing counties. The least dense losing counties had 100 percent similarity while the most dense growing counties had only 40 percent that were similar.

Of the 22 growing counties, 12, or 55 percent, had white growth only. Six of these 12 were in the highest density class. Thus while a growing county did not automatically draw growth from both races, losing counties (with only a few exceptions) tended to lose population from both races. Eighty-seven percent of losing counties lost both whites and nonwhites.

The high out-migration rates of nonwhites from the state must be explained by factors other than a high percent of nonwhites. In general, this analysis indicates that the chief factors in heavy nonwhite losses are overpopulation in the agricultural sector and lack of an urban-industrial growth which provides job opportunities for nonwhites.[8]

County Population Centers

Inasmuch as population trends in Mississippi have been toward increasing concentrations in more limited areas, an attempt was made to find out if this type of trend also existed within counties. An unrefined tabulation of the number of growing and losing population centers in each county was made.

All population centers listed by the Census were included in the tabulation. No

[8]Race differences in migration in Mississippi also fit the pattern reported by Calvin Beale in the report cited in footnote 4. Dr. Beale found from the 1967 Survey of Economic Opportunity that black rural-urban migration was usually interregional (or long distance) while white movers tended to stay within the region (South). It is hoped that further analysis of Mississippi's white in-migration made from incoming census data will indicate the origin of these migrants.

Table 5. Percent of Counties in Each Density-Growth Category Scoring Zero on Components of Growth Prediction Scores

Growth Pattern	All Types	DENSITY TYPE* 1	2	3	4
		PERCENTS SCORING ZERO ON COLOR ONLY			
Growing	27.3	40.0	50.0	0.0	0.0
Stable	25.0	33.0	100.0	0.0	0.0
Losing	3.8	25.0	0.0	0.0	0.0
All	12.2	33.3	20.0	0.0	0.0
		PERCENTS SCORING ZERO ON URBANIZATION ONLY			
Growing	27.7	0.0	0.0	50.0	66.0
Stable	50.0	0.0	0.0	100.0	100.0
Losing	44.2	12.5	30.0	70.6	41.2
All	39.0	4.8	20.0	71.4	52.0
		PERCENTS SCORING ZERO ON BOTH RACE AND URBANIZATION COMPONE			
Growing	13.6	10.0	25.0	50.0	0.0
Stable	0.0	0.0	0.0	0.0	0.0
Losing	46.2	50.0	50.0	29.4	58.8
All	32.9	23.8	40.0	28.6	40.0

*See Table 3 for definition.

Table 6. Percent of Population Centers Experiencing Growth for Categories of Counties Classified by Density and Growth Pattern

Growth Pattern	All Types	DENSITY TYPE 1	2	3	4
Growing	83.3	78.0	100.0	100.0	84.6
Stable	69.6	54.0	100.0	80.0	80.0
Losing	72.5	74.0	82.0	68.2	68.6
The State	74.6	73.6	86.5	69.9	72.4

ols were used for size of center or f growth. Table 6 shows the percent pulation centers in the counties of growth-density category which grew en 1960 and 1970.

differences for categories are not ssive, although there is a tendency igher proportions of the centers to in all growing counties. The ions by density class are very nal. However, it is interesting to note he lowest percent growing is found in able-highest density type, a class of counties which all experienced vely early urban growth.

seems reasonable to conclude that ation centers once established, tend w whether or not the regions in which they are located are growing. Further, it seems that past urban-industrial growth does not insure continued growth. The trend toward population concentration does seem to be a general pattern rather than one restricted to only the larger urban centers.

In conclusion, Mississippi is continuing to experience growing urban concentration and increased rural depletion of population, according to incoming 1970 Census returns. The net results have been gradual changes in the color composition and the distribution of population throughout the state, and a reversal, during the last decade, from net loss to net growth for the state as a whole.

7.-POPULATION GROWTH TRENDS BY RACE FOR MISSISSIPPI COUNTIES RANKED BY 1950 TO 1970 GROWTH TRENDS AND BY 1950 DENSITY

		POPULATION						
		Total			White		Nonwhite	
y	Density*	Number	Percent of State	Percent Change Per Decade**	Number	Percent of State	Number	Percent of State
	46.9	2,216,912	100.0	1.8	1,393,283	100.0	823,629	100.0
	46.1	2,178,141	100.0	-0.04	1,257,546	100.0	920,595	100.0
	46.1	2,178,914	100.0	-0.2	1,188,632	100.0	990,282	100.0
				Growing Counties				
ity Class 1								
S								
	245.4	214,973	9.7	14.9	130,592	9.4	84,381	10.2
	213.3	187,045	8.6	31.6	112,205	8.9	74,840	8.1
	162.1	142,164	6.5	32.5	78,247	6.6	63,917	6.4
SON								
	230.1	134,582	6.1	12.6	111,061	8.0	23,521	2.8
	204.5	119,489	5.5	42.1	100,233	8.0	19,256	2.1
	143.7	84,073	3.8	65.5	70,652	5.9	13,421	1.4
ST								
	123.6	57,849	2.6	9.7	43,524	3.1	14,325	1.7
	112.4	52,722	2.4	17.0	37,970	3.0	14,752	1.6
	96.1	45,055	2.1	29.1	32,090	2.7	12,965	1.3
RDALE								
	94.8	67,087	3.0	-	46,186	3.3	20,901	2.5
	93.1	67,119	3.1	4.6	43,635	3.5	23,484	2.6
	90.6	64,171	2.9	10.2	40,795	3.4	23,376	2.4
	101.4	46,148	2.1	13.7	36,571	2.6	9,577	1.2

Growing Counties (continued)

Density Class 1							
1960	89.2	40,589	1.9	6.2	30,300	2.4	10,289
1950	84.0	38,237	1.8	-1.5	27,578	2.3	10,659
LOWNDES							
1970	97.8	49,700	2.2	6.6	33,336	2.4	16,364
1960	91.8	46,639	2.1	23.2	28,871	2.3	17,768
1950	74.5	37,852	1.7	7.4	19,442	1.6	18,410
ADAMS							
1970	83.1	37,293	1.7	-1.2	19,366	1.4	17,927
1960	84.2	37,730	1.7	17.0	19,035	1.5	18,695
1950	72.0	32,256	1.5	18.4	16,153	1.4	16,103
WARREN							
1970	77.4	44,981	2.0	6.6	26,474	1.9	18,507
1960	72.6	42,206	1.9	6.5	22,447	1.8	19,759
1950	68.2	39,616	1.8	0.1	19,524	1.6	20,092
OKTIBBEHA							
1970	63.3	28,752	1.3	9.8	18,569	1.3	10,183
1960	57.7	26,175	1.2	6.5	14,727	1.2	11,448
1950	54.1	24,569	1.1	10.9	12,818	1.1	11,751
DESOTO							
1970	75.4	35,885	1.6	50.2	23,235	1.7	12,650
1960	50.2	23,891	1.1	-2.9	9,248	.73	14,643
1950	51.7	24,599	1.1	-7.7	8,077	.67	16,522
Density Class 2							
TATE							
1970	45.8	18,544	.83	2.2	9,777	.70	8,767
1960	44.8	18,138	.83	0.7	7,696	.61	10,442
1950	44.5	18,011	.82	-6.7	7,640	.64	10,371
GRENADA							
1970	46.1	19,854	.89	7.8	11,154	.80	8,700
1960	42.7	18,409	.84	-2.2	9,352	.74	9,057
1950	43.7	18,830	.86	-1.2	9,001	.75	9,829
CLAY							
1970	45.5	18,840	.84	-0.5	9,517	.68	9,323
1960	45.7	18,933	.86	6.6	9,214	.73	9,719
1950	42.9	17,757	.81	-6.7	7,660	.64	10,097
JACKSON							
1970	119.5	87,975	4.0	58.5	73,547	5.3	14,428
1960	75.4	55,522	2.5	76.8	44,658	3.6	10,864
1950	42.7	31,401	1.4	52.4	24,664	2.1	6,737
Density Class 3							
RANKIN							
1970	56.7	43,933	2.0	28.0	31,529	2.3	12,404
1960	44.2	34,322	1.6	18.8	21,504	1.7	12,818
1950	37.3	28,881	1.3	3.4	15,210	1.3	13,671
LAFAYETTE							
1970	36.2	24,181	1.1	13.2	17,313	1.2	6,868
1960	32.0	21,355	.98	-6.3	14,110	1.1	7,245
1950	34.1	22,798	1.0	7.2	14,709	1.2	8,089
Density Class 4							
LAMAR							
1970	30.4	15,209	.68	11.2	13,187	.94	2,022
1960	27.4	13,675	.62	3.4	11,443	.90	2,232
1950	26.5	13,225	.60	9.3	11,119	.93	2,106
PEARL RIVER							
1970	33.6	27,802	1.2	24.1	22,688	1.6	5,114
1960	27.1	22,411	1.0	8.6	17,221	1.4	5,190
1950	24.9	20,641	.94	7.9	16,148	1.4	4,493

g Counties (continued)

Class 4

)CK							
36.1	17,387	.78	23.8	14,894	1.1	2,493	.30
28.9	14,039	.64	18.1	11,784	.93	2,255	.24
24.5	11,891	.54	5.0	9,852	.82	2,039	.20
;E							
25.9	12,459	.56	12.8	11,007	.79	1,452	.17
23.1	11,098	.50	10.8	9,811	.78	1,287	.13
20.8	10,012	.45	15.0	8,781	.73	1,231	.12
IE							
11.7	8,545	.38	2.1	6,662	.47	1,883	.22
11.5	8,366	.38	1.8	6,443	.51	1,923	.20
11.3	8,215	.37	-13.6	6,711	.56	1,504	.15
18.1	8,101	.36	15.5	6,220	.44	1,881	.22
15.7	7,013	.32	12.0	5,302	.42	1,711	.18
14.0	6,264	.28	1.8	4,899	.41	1,365	.13

Stable Counties

ity Class 1

INGTON							
96.2	70,581	3.2	-10.2	31,803	2.3	38,778	4.7
107.1	78,638	3.6	11.5	35,239	2.8	43,399	4.7
96.1	70,504	3.2	4.3	23,436	2.0	47,068	4.8
S							
80.3	56,357	2.5	-5.3	42,403	3.0	13,954	1.7
84.8	59,542	2.7	4.0	44,095	3.5	15,447	1.7
81.5	57,235	2.6	16.3	42,207	3.6	15,028	1.5
RN							
67.1	27,179	1.2	7.5	23,951	1.7	3,228	.39
62.4	25,282	1.16	-6.9	21,949	1.7	3,333	.36
67.1	27,158	1.2	0.7	23,254	2.0	3,904	.39

ty Class 2

ISS							
48.2	20,133	.90	12.2	17,776	1.3	2,357	.28
42.9	17,949	.82	-9.4	15,763	1.2	2,186	.23
47.4	19,810	.90	-5.3	17,477	1.5	2,333	.23

ty Class 3

34.7	21,369	.96	0.9	14,254	1.0	7,115	.86
34.5	21,187	.97	-2.3	13,050	1.0	8,137	.88
35.3	21,681	.99	-6.3	12,310	1.0	9,371	.94
MBA							
31.1	16,847	.75	11.7	15,882	1.1	965	.11
27.9	15,080	.69	-12.4	14,206	1.1	874	.09
31.8	17,216	.79	-13.6	16,279	1.4	937	.09

y Class 4

20.1	16,650	.75	2.4	11,169	.80	5,481	.66
19.7	16,258	.74	-4.4	10,449	.83	5,809	.63
20.6	17,010	.78	0.5	10,792	.90	6,218	.62
13.9	9,065	.40	3.7	6,674	.47	2,391	.29
13.4	8,745	.40	-4.0	6,333	.50	2,412	.26
13.9	9,108	.41	-2.0	6,897	.58	2,211	.22

Losing Counties

Density Class 1							
LEFLORE							
1970	71.1	42,111	1.9	-10.7	17,550	1.3	24,561
1960	79.6	47,142	2.2	-9.0	16,699	1.3	30,443
1950	87.5	51,813	2.4	-3.0	16,482	1.4	35,331
COAHOMA							
1970	71.1	40,447	1.8	-12.5	14,232	1.0	26,215
1960	81.1	46,212	2.1	-6.4	14,630	1.2	31,582
1950	86.6	49,361	2.3	2.1	13,702	1.2	35,659
CALHOUN							
1970	71.1	14,623	.65	-8.3	10,807	.77	3,816
1960	81.1	15,941	.73	-13.2	11,595	.92	4,346
1950	86.6	18,369	.84	-12.1	14,080	1.2	4,289
PIKE							
1970	77.6	31,756	1.4	-9.4	17,903	1.3	13,853
1960	85.5	35,063	1.6	-0.2	19,655	1.6	15,408
1950	85.7	35,137	1.6	0.4	19,428	1.6	15,709
SUNFLOWER							
1970	53.4	37,047	1.7	-19.0	13,619	.97	23,428
1960	66.0	45,750	2.1	-18.3	14,730	1.2	31,020
1950	80.9	56,031	2.6	-8.2	17,872	1.5	38,159
BOLIVAR							
1970	53.5	49,409	2.2	-9.3	18,750	1.3	30,659
1960	59.0	54,464	2.5	-13.6	17,521	1.4	36,943
1950	68.3	63,004	2.9	-6.8	19,868	1.7	43,136
QUITMAN							
1970	38.6	15,888	.71	-24.4	6,687	.47	9,201
1960	51.0	21,019	.96	-18.8	7,715	.61	13,304
1950	62.8	25,885	1.2	-4.8	10,183	.85	15,702
HUMPHREYS							
1970	34.7	14,601	.65	-23.5	5,089	.36	9,512
1960	45.4	19,093	.87	-17.4	5,758	.45	13,335
1950	54.9	23,115	1.1	-12.0	7,013	.59	16,102
Density Class 2							
UNION							
1970	45.3	19,096	.86	1.0	16,145	1.2	2,951
1960	44.8	18,904	.86	-6.7	15,592	1.2	3,312
1950	48.0	20,262	.92	-7.3	16,626	1.4	3,636
LINCOLN							
1970	44.7	26,198	1.2	-2.1	18,138	1.3	8,060
1960	45.7	26,759	1.2	-4.1	18,407	1.5	8,352
1950	47.6	27,899	1.3	1.4	18,714	1.6	9,185
TALLAHATCHIE							
1970	30.0	19,338	.87	-19.7	7,657	.54	11,681
1960	37.4	24,081	1.1	-21.0	8,580	.68	15,501
1950	47.3	30,486	1.4	-10.8	11,078	.93	19,408
TUNICA							
1970	25.9	11,854	.53	-29.5	3,225	.23	8,629
1960	36.7	16,826	.77	-22.3	3,505	.27	13,321
1950	47.3	21,664	.99	-4.2	3,939	.33	17,725
MONROE							
1970	44.3	34,043	1.5	0.3	23,650	1.7	10,393
1960	44.2	33,953	1.6	-7.1	21,932	1.7	12,021
1950	47.5	36,543	1.7	-2.9	22,829	1.9	13,714
MADISON							
1970	40.9	29,737	1.3	-9.6	11,148	.80	18,589
1960	45.3	32,904	1.5	-2.8	9,267	.73	23,637

Counties (continued)							
Class 2							
46.6	33,860	1.5	-9.7	8,926	.75	24,934	2.5
BA							
36.6	20,802	.93	-0.6	15,091	1.1	5,711	.69
36.8	20,927	.96	-18.7	15,026	1.2	5,901	.64
45.3	25,730	1.2	-7.7	19,064	1.6	6,666	.67
A							
38.7	26,829	1.2	-6.8	13,061	..93	13,768	1.7
41.5	28,791	1.3	-7.9	12,565	.99	16,226	1.8
45.1	31,271	1.4	-9.2	13,782	1.2	17,489	1.8
IN							
41.6	22,871	1.0	-1.8	15,739	1.1	7,132	.86
42.4	23,293	1.1	-2.8	15,408	1.2	7,885	.85
43.6	23,967	1.1	-0.5	15,575	1.3	8,392	.84
S							
30.1	23,120	1.0	-14.7	7,345	.52	15,775	1 9
35.2	27,096	1 2	-18.6	7,595	.60	19,501	2.1
43.3	33,301	1.5	-16.1	8,824	74	24,477	2.5
ty Class 3							
TOC							
34.7	17,363	.78	0 8	14,254	1.0	3,109	.37
34.4	17,232	.79	-13.8	13,946	1 1	3,286	35
39.9	19,994	.91	-12.7	16,178	1 4	3,816	.38
N							
32.7	18,983	.85	-2.7	13,352	95	5,631	.68
33.7	19,517	89	-14 0	12,950	1.0	6 567	71
39.1	22,681	1.0	-6.5	14,829	1.2	7,852	.79
H							
31.7	24,749	1.1	-2 5	12,298	88	12,451	1.5
34.6	27,051	1.2	-11.3	12,992	1.0	14,059	1 5
39.0	30,493	1.4	-10.2	14,210	1.2	16,283	1.6
AI L							
31.0	12,500	.56	-7.5	7,403	.53	5,097	61
33.5	13,512	.62	-13 2	7,412	.58	6,100	.66
38.6	15,563	.71	-11.2	8,397	.70	7,166	.72
CTON							
33.7	14,002	.63	2.7	9,426	.67	4,576	.55
32.8	13,637	.62	-15.0	8,896	.70	4,741	.51
38.5	16,036	.73	-5.8	10,823	91	5,213	.52
29.1	27,304	1 2	-13.7	12,690	.91	14,614	1.8
33.7	31,653	1.4	-11 4	12,862	1.0	18,791	2.0
38.1	35,712	1.6	-10.9	13,632	1.1	22,080	2.2
JSHA							
29.1	11,915	.53	-4.7	7,071	.50	4,844	.58
33.7	12,502	.57	-17.7	6,962	.55	5,540	.60
38.1	15,191	69	-17 4	8,529	.71	6,662	.67
H							
34 2	15,852	.71	5 0	13,260	.95	2,592	.31
32 5	15,093	69	-13.9	12,337	98	2,756	.29
37 8	17,522	.80	-11.0	14,129	1.2	3,393	.34
NSAW							
33.2	16,805	.75	-0.5	10,819	.77	5,986	72
33.4	16,891	.77	-10.9	10,380	.82	6,511	.70
37.5	18,951	.86	-11 6	10,525	..88	8,426	85
FSON DAVIS							
31.2	12,936	58	-4.5	6,435	.46	6,501	.78
32.7	13,540	.62	-12 6	6,126	.48	7,414	.80
37.4	15,500	.71	-2.3	6,890	.57	8,610	.86

Losing Counties (continued)

Density Class 3							
SIMPSON							
1970	34.0	19,947	.89	-2.5	13,678	.98	6,269
1960	34.8	20,454	.93	-6.3	13,254	1.0	7,200
1950	37.2	21,819	1.0	-0.9	14,549	1.2	7,270
LEAKE							
1970	29.2	17,085	.77	-8.4	10,452	.75	6,633
1960	31.8	18,660	.85	-13.7	10,559	.83	8,101
1950	36.9	21,610	99	-12.0	12,446	1.0	9,164
ATTALA							
1970	27.0	19,570	.88	-8.3	11,632	.83	7,938
1960	29.5	21,335	.97	-19.9	11,789	.93	9,546
1950	36.8	26,652	1.2	-11.8	15,084	1.3	11,568
WINSTON							
1970	30.4	18,406	.82	-4.4	11,065	.79	7,341
1960	31.8	19,246	.88	-13.4	10,853	.86	8,393
1950	36.7	22,231	1.0	-2.3	12,938	1.1	9,293
MONTGOMERY							
1970	32.1	12,918	.58	-3.0	7,121	.51	5,797
1960	33.1	13,320	.61	-7.9	7,349	.58	5,971
1950	35.9	14,470	.66	-7.9	8,246	.69	6,224
MARSHALL							
1970	33.8	24,027	1.1	-1.9	9,101	.65	14,926
1960	34.5	24,503	1.1	-2.4	7,264	.57	17,239
1950	35.4	35,106	1.2	-1.6	7,374	.62	17,732
TISHOMINGO							
1970	33.7	14,940	.67	7.6	14,268	1.0	672
1960	31.3	13,889	.63	-10.6	13,210	1.1	679
1950	35.0	15,544	.71	-8.4	14,738	1.2	806
Density Class 4							
SHARKEY							
1970	20.5	8,937	.40	-16.8	3,125	.22	5,812
1960	24.6	10,738	.49	-16.8	3,247	.25	7,491
1950	29.6	12,903	.59	-16.4	3,707	.31	9,196
LAWRENCE							
1970	25.7	11,137	.50	9.0	7,553	.54	3,584
1960	23.6	10,215	.46	-19.2	6,354	.50	3,861
1950	29.2	12,639	.58	-9.6	7,881	.66	4,758
NOXUBEE							
1970	20.6	14,288	.64	-15.1	4,844	.34	9,444
1960	24.2	16,826	.77	-16.0	4,724	.37	12,102
1950	28.8	20,022	.91	-22.0	5,117	.43	14,905
WEBSTER							
1970	24.2	10,047	.45	-5.0	7,789	.55	2,258
1960	25.4	10,580	.48	-8.8	7,938	.63	2,642
1950	27.9	11,607	.53	-18.0	8,915	.75	2,692
CLARKE							
1970	21.6	15,049	.67	-8.8	9,631	.69	5,418
1960	23.7	16,493	.75	-14.8	10,001	.79	6,492
1950	27.8	19,362	.88	-6.0	11,479	.96	7,883
JASPER							
1970	23.4	15,994	.72	-5.4	8,564	.61	7,430
1960	24.8	16,909	.77	-10.6	8,402	.66	8,507
1950	27.7	18,912	.86	-2.9	9,193	.77	9,719
AMITE							
1970	18.9	13,763	.62	-11.6	6,814	.48	6,949
1960	21.4	15,573	.71	-19.1	7,130	.56	8,443
1950	26.4	19,261	.88	-12.0	8,823	.74	10,438
CHOCTAW							
1970	20.2	8,440	.38	0.2	6,069	.43	2,371

Counties (continued)

Class 4

20.2	8,423	.38	-23.5	5,903	.46	2,520	.27
26.4	11,009	.50	-18.7	7,680	.64	3,329	.33
21.1	13,561	.61	-5.2	10,609	.76	2,952	.35
22.3	14,303	.65	-14.6	11,056	.87	3,247	.35
26.1	16,740	.76	-13.7	13,350	1.1	3,390	.34
ORNE							
20.6	10,086	.45	-7.0	2,536	.18	7,550	.91
22.3	10,845	.49	-9.2	2,600	.20	8,245	.89
24.6	11,944	.54	-6.8	3,010	.25	8,934	.90
LL							
14.8	9,397	.42	-15.9	4,615	.33	4,782	.58
17.5	11,177	.51	-27.9	4,677	.37	6,500	.70
24.3	15,499	.71	-24.9	6,663	.56	8,836	.89
RSON							
17.8	9,295	.41	-8.4	2,296	.16	6,999	.84
19.5	10,142	.46	-10.3	2,489	.19	7,653	.83
21.7	11,306	.51	-19.1	2,887	.24	8,419	.85
N							
18.2	7,505	.33	-2.8	4,350	.31	3,155	.38
18.7	7,723	.35	-12.2	4,114	.32	3,609	.39
21.3	8,793	.40	-15.7	4,943	.41	3,850	.38
R							
13.5	10,233	.46	-16.6	4,488	.32	5,745	.69
16.2	12,277	.56	-22.8	4,828	.38	7,449	.80
21.0	15,893	.72	-27.3	6,460	.54	9,433	.95
SON							
16.5	11,099	.50	-16.1	3,588	.25	7,511	.91
19.6	13,235	.60	-6.2	3,807	.30	9,428	1.0
20.9	14,116	.64	-11.5	4,358	.36	9,758	.98
IN							
14.1	8,011	.36	-13.7	4,897	.35	3,114	.37
16.3	9,286	.42	-15.0	5,486	.43	3,800	.41
19.2	10,929	.50	-12.6	6,625	.55	4,304	.43
JENA							
6.6	2,737	.12	-23.5	1,033	.07	1,704	.20
8.6	3,576	.16	-28.0	1,176	.09	2,400	.26
12.0	4,966	.22	-22.8	1,617	.13	3,349	.33

nber of persons per square mile.

e rates of change given in the 1950 rows are for the 1940 to 1950 decade; e in the 1960 rows are for the 1950 to 1960 decade; and those in the 1970 for the 1960 to 1970 decade.

ces: United States Bureau of the Census Population Reports for the years cated.

Mississippi Cotton Variety Tests Delta And Hill Sections, 1971

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1971 Test Results

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MISSISSIPPI COTTON VARIETY TESTS FOR 1971

IN THE DELTA

By R. R. BRIDGE, W. R. MEREDITH, Jr., and J. F. CHISM

n variety tests were conducted by lta Branch Experiment Station in n the Delta Station at Stoneville, er Plantation near Yazoo City, ner Plantation near Sumner, and Farms near Tunica. Three tests onducted at Stoneville. These tests n a Bosket very fine sandy loam, e sandy loam, and a Sharkey clay be.

een varieties were grown at all ns. Eleven varieties grown at ille and Tunica are included in a ative, Belt-wide, variety testing m.

ults are reported at each location for 71 variety tests. Yield data were on the weight of cotton harvested two-row plots. Each entry was nized and replicated six times. Lint ntage and fiber property deter- ons were obtained from hand- samples. Fiber property data were ined by the U.S. Cotton Fiber atory of the Plant Science Research on, Agricultural Research Service, Department of Agriculture, Knox- Tennessee.

ormance data of varieties tested in re shown in Tables 1 through 7. Table s the average performance of 11 ies grown at 11 locations in 1970 and Statistical analysis of the yield data for all locations indicated that the location in which a variety was grown had an effect on its yield performance. Some varieties tended to perform better at one location than they did at another location. These variety X location interactions were partially due to rainfall distribution, seasonal temperatures, disease (boll-rot and Verticillium wilt), and herbicide applications.

Soil temperature at the test sites was only fair for seed germination and seedling development. High intensity rains and low temperatures at Stoneville resulted in slow seedling development. Growing conditions varied from one location to another. A dry period, May 20 - August 1, was present at Stoneville. Continuous high moisture levels at Yazoo City caused late plant development and freeze damage. Due to these conditions boll-rot significantly reduced yields at Yazoo City. A late maturing crop at Tunica was damaged by an early November freeze.

Dr. Bridge is Plant Breeder, Delta Branch, Mississippi Agricultural and Forestry Experiment Station; Dr. Meredith is Research Geneticist, Plant Science Research Division, Agricultural Research Service, U. S. Department of Agriculture; and Assistant Agronomist, Delta Branch Experiment Station, respectively, Stoneville, Mississippi.

Table 1: Results 1971 Cotton Variety Test - Stoneville, Mississippi *

Variety	LINT PER ACRE						FIBER PROPERTIES				
			Percent			Boll	Length				
	Total	First pick	first pick	Lint percent	Seed index	size grams	2.5%	50%	Strength gms/tex	Elonga-tion	Micro-naire
Delcot 277	1198	1106	92	34.7	12.9	7.10	1.27	.64	19.86	9.50	3.70
Deltapine 6225	1186	1013	85	38.4	10.7	5.71	1.18	.57	19.83	7.15	4.57
Deltapine 16	1183	1010	85	35.3	11.4	6.34	1.22	.58	19.14	8.93	4.12
Deltapine 45A	1178	1075	91	36.5	11.4	6.01	1.19	.60	19.16	8.44	4.12
Coker 310	1133	993	88	37.2	11.4	6.06	1.26	.57	19.17	8.65	4.27
Stoneville 213	1132	987	87	36.3	11.4	5.96	1.18	.58	18.43	7.62	4.66
Stoneville 603	1102	983	89	34.6	11.9	6.00	1.19	.58	18.37	7.83	4.21
Stoneville 7A	1079	913	85	36.5	11.4	5.78	1.19	.56	18.88	6.70	4.60
DES 67-13	1068	903	85	35.5	11.4	5.85	1.21	.59	18.01	8.16	4.28
Coker 201	995	856	86	37.6	11.6	6.33	1.19	.59	19.15	7.13	4.44
Coker 417	971	845	87	35.1	11.6	6.44	1.26	.62	20.13	7.22	4.02
Paymaster 111	868	713	82	34.4	12.7	7.50	1.13	.57	19.12	6.46	4.40
Acala SJ-1	763	645	84	34.9	13.7	6.83	1.21	.60	21.68	7.62	3.98
Average	1066	926	87	35.9	11.8	6.30	1.206	.588	19.30	7.80	4.26
LSD .05	70										
LSD .01	93										
C.V.	5.68										

PLANTED: April 19, 1971
HARVESTED: September 28 and October 20, 1971
* Soil: Bosket very fine sandy loam.

Table 2: Results of 1971 Cotton Variety Test - Tunica, Mississippi.

Variety	LINT PER ACRE						FIBER PROPERTIES				
			Percent			Boll	Length				
	Total	First pick	first pick	Lint percent	Seed index	size grams	2.5%	50%	Strength gms/tex	Elonga-tion	Micro-naire
Delcott 277	1022	904	88	38.6	13.0	6.54	1.24	.62	19.09	8.66	4.11
Deltapine 45A	1014	847	83	39.1	11.9	5.84	1.16	.58	18.55	7.45	4.68
Deltapine 6225	998	830	83	40.9	10.6	5.43	1.16	.55	19.03	7.77	4.43
Coker 310	975	842	86	40.0	11.4	5.34	1.24	.57	18.72	7.45	4.63
Coker 417	972	807	83	37.8	12.1	6.25	1.23	.60	19.37	6.71	4.41
Stoneville 7A	970	776	80	39.2	11.8	5.43	1.16	.54	16.85	6.34	4.83
Deltapine 16	960	808	84	38.3	11.2	5.92	1.22	.60	18.11	8.08	4.46
Stoneville 213	932	759	81	39.1	11.9	5.81	1.15	.56	17.82	7.37	5.22
DES 67-213	906	757	83	38.7	10.9	5.66	1.13	.54	17.54	7.35	4.72
Stoneville 603	890	753	85	36.5	12.7	5.82	1.19	.59	19.27	7.48	4.63
Coker 201	805	644	80	39.7	12.6	6.00	1.16	.58	19.05	6.53	4.71
Paymaster 111	704	557	79	36.4	12.4	7.22	1.11	.55	17.94	6.86	4.85
Acala SJ-1	683	530	77	36.8	14.3	6.59	1.17	.60	22.19	6.50	4.65
Average	910	755	83	38.5	12.0	5.99	1.178	.575	18.73	7.27	4.64
LSD .05	172										
LSD .01	229										
C.V.	16.39										

PLANTED: May 3, 1971.
HARVESTED: October 27 and November 11, 1971.
SOIL: Sandy loam.

Table 3: Results of 1971 Cotton Variety Test - Stoneville, Mississippi **

Variety	LINT PER ACRE						FIBER PROPERTIES				
			Percent			Boll	Length				
	Total	First pick	first pick	Lint percent	Seed index	size grams	2.5%	50%	Strength gms/tex	Elonga-tion	Micro-naire
Deltapine 16	1196	1011	85	38.5	11.0	6.15	1.19	.57	18.13	8.84	4.36
Coker 310	1194	996	83	40.8	11.0	5.74	1.22	.57	19.04	6.83	4.47
Deltapine 45A	1151	1017	88	39.2	10.4	5.78	1.12	.54	18.35	8.33	4.73
Stoneville 213	1129	898	80	39.3	11.0	5.71	1.14	.55	17.67	8.16	5.01
Deltapine 6225	1077	844	78	40.8	10.9	5.70	1.16	.57	19.37	7.62	4.66
Stoneville 7A	1064	812	76	39.2	11.1	5.63	1.16	.55	17.41	6.62	4.84
Stoneville 603	1055	893	85	35.8	12.2	5.85	1.16	.55	18.94	8.98	4.42
Delcot 277	1052	949	90	36.2	13.0	7.05	1.23	.58	20.18	8.45	3.88
DES 67-213	981	756	77	38.6	10.6	5.82	1.15	.55	17.24	7.77	4.52
Coker 201	968	731	75	38.9	11.2	5.99	1.14	.55	19.16	7.60	4.47
Coker 417	940	780	83	36.6	11.7	6.05	1.24	.58	19.03	6.99	4.11
Acala SJ-1	814	624	77	36.4	13.9	6.91	1.17	.57	21.89	6.89	4.52
Paymaster 111	763	602	79	34.7	13.2	7.69	1.12	.56	18.24	7.25	4.25
Average	1029	839	81	38.1	11.6	6.16	1.169	.56	18.82	7.72	4.48
LSD .05	89										
LSD .01	118										
C.V.	7.50										

PLANTED: April 22, 1971
HARVESTED: October 7 and November 11, 1971
** Soil: Dundee sandy loam

Table 4: Results of 1971 Cotton Variety Test - Sumner, Mississippi.

Variety	LINT PER ACRE						FIBER PROPERTIES				
			Percent			Boll	Length				
	Total	First pick	first pick	Lint percent	Seed index	size grams	2.5%	50%	Strength gms/tex	Elonga-tion	Micro-naire
Coker 310	1533	1235	80	41.2	11.2	5.72	1.25	.60	18.00	8.07	4.86
Deltapine 6225	1519	1175	77	41.1	10.7	5.49	1.17	.57	18.99	8.02	4.94
Deltapine 45A	1515	1260	83	39.6	11.3	5.81	1.16	.58	18.84	8.63	4.78
Delcot 277	1480	1253	85	38.2	13.3	6.63	1.21	.58	18.64	9.90	4.20
Stoneville 213	1467	1140	78	39.0	11.6	5.96	1.16	.58	17.03	8.34	5.06
Stoneville 7A	1462	1115	76	39.3	11.5	5.68	1.17	.57	16.57	7.12	5.21
Coker 201	1453	1098	76	40.5	11.5	5.86	1.18	.56	18.48	7.02	4.92
Coker 417	1432	1118	78	38.2	12.1	6.01	1.23	.59	18.99	7.19	4.50
DES 67-213	1417	1094	77	38.7	11.4	5.71	1.17	.56	17.03	8.52	4.82
Stoneville 603	1409	1136	81	35.9	12.7	6.00	1.20	.58	18.01	8.28	4.77
Deltapine 16	1404	1147	82	38.7	11.7	6.31	1.19	.57	17.83	9.35	4.90
Acala SJ-1	1144	824	72	36.9	14.7	6.72	1.19	.57	20.41	7.19	4.52
Paymaster 111	981	666	68	35.6	14.4	7.06	1.10	.54	18.40	7.90	4.67
Average	1401	1097	78	38.7	12.2	6.07	1.183	.573	18.25	8.12	4.78
LSD .05	96										
LSD .01	129										
C.V.	5.99										

PLANTED: April 27, 1971
HARVESTED: October 25 and NOvember 11, 1971
SOIL: Dundee silty loam

Table 5: Results of 1971 Cotton Variety Test - Yazoo City, Mississippi.

Variety	LINT PER ACRE				FIBER PROPERTIES				
				Boll	Length				
	Total	Lint percent	Seed index	size grams	2.5%	50%	Strength gms/tex	Elonga-tion	Micro-naire
Coker 310	795	40.2	11.1	5.52	1.25	.58	18.25	7.62	4.69
Coker 201	761	39.5	11.8	5.93	1.17	.58	17.85	6.95	4.91
Deltapine 6225	752	40.4	10.8	5.41	1.17	.57	18.75	7.63	4.82
Coker 417	749	37.6	11.7	5.75	1.23	.58	18.40	6.69	4.26
Acala SJ-1	741	35.5	14.2	7.17	1.19	.60	20.79	6.68	4.48
DES 67-2[illegible]	723	37.0	10.8	5.56	1.15	.55	16.87	7.78	4.47
Deltapine 45A	711	38.9	11.2	5.59	1.16	.59	18.46	8.02	4.74
Stoneville 213	660	38.2	12.0	5.76	1.15	.57	17.48	7.51	5.12
Deltapine 1[illegible]	654	38.6	10.9	5.89	1.20	.59	17.80	9.21	4.48
Stoneville 7A	625	38.7	11.5	5.39	1.16	.56	17.27	6.19	5.03
Stoneville 603	620	36.0	12.4	5.97	1.17	.55	18.55	8.12	4.66
Delcot 277	576	36.7	12.9	6.80	1.25	.61	18.96	9.67	4.17
Paymaster 111	488	35.1	14.0	7.18	1.08	.57	18.32	6.52	4.90
Average	681	37.9	11.9	5.99	1.179	.577	18.29	7.58	4.67
LSD .05	85								
LSD .01	113								
C.V.	10.85								

PLANTED: April 16, 1971
HARVESTED: November 17, 1971
SOIL: Sandy loam

Table 6: Results of 1971 Cotton Variety Test - Stoneville, Mississippi ***

Variety	LINT PER ACRE						FIBER PROPERTIES				
			Percent			Boll	Length				
	Total	First pick	first pick	Lint percent	Seed index	size grams	2.5%	50%	Strength gms/tex	Elonga-tion	Micro-naire
Stoneville 7A	627	473	75	39.5	10.4	5.07	1.15	.53	17.46	6.09	5.16
Deltapine 6225	621	483	78	39.8	10.3	5.04	1.16	.56	19.17	7.25	4.96
Acala SJ-1	615	420	68	36.3	13.6	6.31	1.18	.59	22.01	6.45	4.60
Delcot 277	611	521	85	37.0	12.4	5.78	1.23	.61	19.70	9.10	4.25
Stoneville 213	585	436	75	38.3	10.9	5.07	1.14	.56	18.26	7.96	5.02
Coker 310	581	465	80	39.0	11.4	4.93	1.23	.59	18.47	7.47	4.81
Coker 201	563	435	77	39.2	11.6	5.15	1.16	.55	17.86	6.37	4.78
Coker 417	559	439	78	36.9	11.4	5.53	1.23	.59	18.85	7.06	4.36
Deltapine 16	557	454	81	37.6	11.0	5.42	1.18	.57	18.65	8.88	4.67
Deltapine 45A	551	452	82	38.4	10.3	5.12	1.12	.55	18.65	7.70	4.61
DES 67-213	511	397	78	37.5	10.8	5.06	1.14	.56	16.89	7.86	4.57
Stoneville 603	490	394	80	35.7	11.9	5.00	1.15	.55	18.79	7.91	4.71
Paymaster 111	438	325	74	36.1	12.8	6.41	1.09	.54	18.91	6.63	4.77
Average	562	438	78	37.8	11.4	5.38	1.166	.565	18.74	7.44	4.71
LSD .05	90										
LSD .01	119										
C.V.	13.84										

PLANTED: April 12, 1971
HARVESTED: October 7 and November 11, 1971
*** Soil: Sharkey clay

Table 7: Average performance of 13 cotton varieties grown at six locations in 1971.

Variety	Lint per acre	Lint percent	Seed index	Boll size	FIBER PROPERTIES			
					Length 2.5%	Strength g/tex	Elongation E_1	Micronaire
Coker 310	1035	39.7	11.2	5.55	1.24	18.61	7.68	4.62
Deltapine 6225	1025	40.2	10.7	5.46	1.17	19.19	7.57	4.73
Deltapine 45A	1020	38.6	11.1	5.69	1.15	18.67	8.09	4.61
Deltapine 16	992	37.8	11.2	6.00	1.20	18.27	8.88	4.50
Delcot 277	990	36.9	12.9	6.65	1.24	19.40	9.21	4.05
Stoneville 213	984	38.3	11.5	5.71	1.15	17.78	7.82	5.01
Stoneville 7A	971	38.7	11.3	5.50	1.16	17.40	6.51	4.94
Coker 417	937	37.0	11.8	6.00	1.24	19.13	6.98	4.28
DES 67-213	934	37.7	11.0	5.61	1.16	17.26	7.91	4.56
Stoneville 603	927	35.7	12.3	5.77	1.18	18.65	8.10	4.57
Coker 201	924	39.2	11.7	5.88	1.17	18.59	6.93	4.70
Acala SJ-1	793	36.1	14.1	6.75	1.18	21.49	6.89	4.46
Paymaster 111	707	35.4	13.2	7.18	1.10	18.49	6.94	4.64

Table 8: Average performance of 11 cotton varieties grown in 11 environments in 1970 and 1971 [1/]

Variety	Lint per acre	Lint percent	Seed index	Boll size	FIBER PROPERTIES			
					Length	Strength	Elongation	Micronaire
					2.5%	g/tex	E_1	
Deltapine 6225	1016	40.3	10.8	5.45	1.15	19.25	7.41	4.80
Deltapine 45A	1006	38.8	11.2	5.68	1.13	18.60	7.91	4.69
Deltapine 16	995	38.1	11.3	6.06	1.18	18.42	8.76	4.64
Coker 310	993	39.0	11.7	5.75	1.23	18.63	7.35	4.63
Stoneville 213	970	38.3	11.5	5.81	1.14	18.00	7.55	4.99
Stoneville 7A	956	38.9	11.3	5.56	1.16	17.69	6.47	4.91
DES 67-213	934	37.6	11.1	5.62	1.15	17.29	7.80	4.58
Coker 417	919	37.0	11.9	5.95	1.22	19.06	6.89	4.30
Stoneville 603	914	35.8	12.5	5.79	1.16	18.95	7.88	4.52
Delcot 277	914	36.7	13.0	6.58	1.22	19.74	8.94	4.07
Coker 201	896	38.8	11.9	5.89	1.16	18.46	6.85	4.69

[1/] 5 locations in 1970 and 6 locations in 1971.

COTTON TESTS IN HILL SECTION

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N. C. EDWARDS, F. T. WITHERS, JR.

Cotton variety tests were conducted at five locations in the Hill Section of Mississippi in 1971. A list of these locations, the soil type, and pertinent cultural practices at each location are given in an accompanying table.

Fourteen varieties were included at all locations. Of these, four were being tested at these locations for the first time. These were: Hybee 100A and Hybee 200A, produced by Pennington Grain and Seed Co., Madison, Georgia; Stoneville 603, produced by Stoneville Pedigreed Seed Co., Stoneville, Mississippi; and DES 67-213, produced by the Delta Branch Experiment Station, Stoneville, Mississippi. Varieties which were previously tested but omitted from the 1971 tests were Hybee 401, McNair 1032B, and Mo-Del.

In addition to the commercial varieties tested, several experimental strains were tested at Verona and State College. In these two tests, Deltapine 16 and Stoneville 213 were included as check varieties for comparison.

Performance data for the varieties and experimental strains tested in 1971 are given in the accompanying tables. Three year average performance for va tested during 1969-71 is also given.

Yield and yield components th reported include lint per acre, lin centage, and boll size. Percent of th yield obtained at first harvest is a cluded for some locations, and is us an indication of earliness of matur

Classer's staple length in 32nds in micronaire were provided for each v and experimental strain at each lo by the U.S.D.A. Cotton Classing Jackson, and are given in the tab addition, results of fiber analyse given for the variety test at State C and Holly Springs and the experi strains test at State College. Fiber reported include strength in th pounds per square inch tensile str 2.5 percent span length, and unif ratio.

Editor's Note: Dr. Douglas is an associate agr and Mr. Andries is an assistant agronomist College; Mr. Coats is superintendent of the Bl Branch Experiment Station at Brooksville; Mr is superintendent of North Mississippi Branch S Holly Springs; Dr. Edwards is agronomist at th Loam Branch Station at Raymond; and Mr. W acting superintendent of the Pontotoc Ridge-Fl Branch Station at Pontotoc, Miss.

-year average lint yield of 9 cotton varieties tested at 6 locations in ill Section in 1969-71.

ariety	State College	Holly Springs	Ponto-toc	Verona	Brooks-ville	Raymond 1/	Ave.
ville 213	773	726	606	878	625	955	760
310	732	703	624	815	639	836	724
201	760	680	654	770	576	841	713
ville 7A	695	763	589	798	593	832	711
ck	756	733	620	802	654	690	709
pine 16	731	672	643	770	574	862	708
King II	663	748	581	786	648	827	708
417	690	687	614	813	592	818	702
pine 45A	749	647	574	750	614	733	677
verage	727	706	611	798	612	821	712

o year average, 1969-1970.

yield, in pounds per acre, of 14 cotton varieties tested at 5 locations te Hill Section in 1971.

ariety	State College	Holly Springs	Pontotoc	Verona	Brooksville	Ave.
200A	848	873	363	877	606	713
100A	841	805	427	839	609	704
King II	821	767	377	769	626	672
7-213	875	823	263	765	589	663
201	879	727	352	734	574	653
310	805	748	389	720	584	649
ville 603	871	860	306	700	496	646
pine 6225	786	753	246	778	664	645
ck	861	750	286	679	606	636
ville 213	824	638	331	783	569	629
417	795	718	354	696	529	618
pine 16	812	711	334	645	559	612
pine 45A	837	690	241	736	549	610
ville 7A	749	774	244	667	553	597
verage	828	759	322	742	579	646

Cotton variety performance at the Black Belt Branch Experiment Station, Brooksville, in 1971.

Variety	Lint/ Acre	Lint %	Bolls/ Lb.	Fiber Properties Staple
	lbs.	%	no.	1/32 in.
Deltapine 6225	644	42.4	85	35.3
Dixie King II	626	38.0	62	34.3
Hybee 100A	609	39.4	78	35.0
Hybee 200A	606	40.4	79	36.0
Hancock	606	38.9	62	34.3
DES 67-213	589	38.9	85	35.0
Coker 310	584	40.8	81	35.6
Coker 201	574	40.7	77	35.0
Stoneville 213	569	39.4	79	35.0
Deltapine 16	559	38.7	76	35.0
Stoneville 7A	553	40.0	78	35.3
Deltapine 45A	549	39.1	78	34.3
Coker 417	529	36.9	75	36.0
Stoneville 603	496	36.4	81	35.3
Average	579	39.2	77	35.1
L.S.D @ .05	74			
@ .01	99			
C.V.	11.1%			

Three-year averages, Black Belt Branch Experiment Station, Brooksville, 1969-71.

Variety	Lint/ Acre	Lint %	Bolls/ Lb.	% 1st Picking	Fiber Properties Staple
	lbs.	%	no.	%	1/32 in.
Hancock	654	39.1	74	70	33.8
Dixie King II	648	38.1	63	64	34.0
Coker 310	639	41.3	69	85	35.1
Stoneville 213	625	39.1	62	82	34.7
Deltapine 45A	644	38.9	61	83	34.1
Stoneville 7A	593	39.4	52	80	35.0
Coker 417	592	37.2	67	79	35.2
Coker 201	576	40.1	67	80	34.7
Deltapine 16	574	38.0	60	82	34.7
Average	612	39.0	63	78	34.5

variety performance at the Northeast Mississippi Branch Experiment
n, Verona, in 1971.

riety	Lint/ Acre	Lint %	Bolls/ Lb.	% 1st Picking	Fiber Properties Staple	Mike
	lbs.	%	no.	%	1/32 in.	Index
200A	877	38.6	72	82	35.6	4.9
100A	839	37.1	74	85	36.3	4.6
ville 213	783	37.3	74	78	35.0	5.1
pine 6225	778	38.6	74	75	35.3	4.7
King II	769	36.2	60	82	35.0	4.7
7-213	765	36.5	74	74	35.0	4.8
pine 45A	736	37.5	77	77	35.3	4.8
201	734	38.5	72	85	35.6	4.9
310	720	37.9	83	84	36.3	4.5
ville 603	700	35.5	76	75	35.3	4.9
417	696	35.3	72	85	36.3	4.3
ck	679	38.4	66	77	34.3	4.8
ville 7A	667	38.0	77	75	34.6	5.0
pine 16	645	36.4	74	81	35.3	4.7
verage	742	372	73	79	35.3	4.7
. @ .05	115					
@ .01	152					
	13.4%					

-year average, Northeast Branch Experiment Station, Verona, 1969-71.

riety	Lint/ Acre	Lint %	Bolls/ Lb.	% 1st[1/] Picking	Fiber Properties Staple	Mike
	lbs.	%	no.	%	1/32 in.	Index
ville 213	878	38.6	79	78	34.6	5.0
310	815	38.7	82	84	35.5	4.4
417	813	36.8	77	85	35.4	4.3
ck	802	39.1	70	77	33.9	4.6
ville 7A	798	39.3	81	75	34.5	4.9
King II	786	37.1	60	82	34.3	4.7
201	770	39.8	75	85	34.9	4.7
pine 16	770	38.0	81	81	34.8	4.5
pine 45A	750	38.0	80	77	34.6	4.9
verage	798	38.3	76	80	34.7	4.6

e year average, 1971.

Performance of experimental cotton strains at the Northeast Branch Experiment Station, Verona, 1971.

Variety	Lint/ Acre	Lint %	Bolls/ Lb.	% 1st Picking	Fiber Propert Staple	l
	lbs.	%	no.	%	1/32 in.	
La Frego 2	944	38.2	77	75	34.5	
St. 7A -Frego -Okra	872	36.4	80	79	34.5	
Deltapine 652	864	39.1	85	71	34.5	
La. Okra 5	835	38.0	77	81	35.0	
La. Okra 2	786	38.2	77	78	34.5	
Stoneville 213	773	36.6	76	73	35.0	
Deltapine 16	752	36.0	75	77	36.0	
Tamcot SP 37	642	34.3	79	84	35.0	
La. Super Okra 2	606	38.7	85	89	34.5	
Lankart 611	578	33.8	57	89	34.5	
Average	765	36.9	76	79	34.8	
L.S.D. @ .05	121					
@ .01	163					
C.V.	10.9%					

Cultural practices used at cotton variety test location in 1971.

Location	Soil Type	$N-P_2O_5-K_2O$ Fertilizer	Plot Size Length	Plot Size Width	Planting Dat
		lbs./A	ft.	no. rows	mo./
State College	Leeper fine sandy loam	70-52-52	30	1	5/2
Holly Springs	Grenada silt loam	64-64-64	70	1	5/4
Pontotoc	Atwood silt loam	136-56-56	50	1	5/4
Verona	Leeper clay loam	84-100-100	50	1	4/2
Brooksville	Houston clay	60-60-60	175	1	4/1

variety performance at the North Mississippi Branch Experiment Station, Holly Springs,

riety	Lint/ Acre	Lint %	Bolls/ Lb.	Fiber Properties Staple Length	Mike	Strength	2.5% Span	UR
	lbs.	%	no.	1/32 in.	Index	M.P.S.I.	in.	%
200A	873	40.0	83	35.6	5.0	79	1.20	48
ille 603	860	37.9	84	35.0	4.9	82	1.13	47
-213	823	40.1	83	34.6	4.9	73	1.12	48
100A	805	40.7	74	36.0	4.8	83	1.20	48
ille 7A	774	40.2	84	35.0	5.3	83	1.15	47
King II	767	39.9	61	35.0	5.0	83	1.12	49
ine 6225	753	41.3	84	35.0	5.0	88	1.16	49
k	750	41.0	72	34.3	4.8	85	1.14	47
310	748	42.6	87	35.6	5.0	81	1.25	48
201	727	40.9	79	35.0	5.1	87	1.16	50
417	718	40.6	79	36.0	4.4	85	1.18	48
ine 16	711	39.2	81	35.3	4.8	79	1.17	49
ine 45A	690	40.1	84	35.0	5.0	79	1.12	49
ille 213	638	39.2	82	34.6	5.4	78	1.15	49
erage	759	40.2	79	35.1	4.9	81	1.16	48
@ .05	86							
@ .01	114							
	11.2%							

-year averages, North Mississippi Branch Experiment Station, Holly gs, 1969-71.

riety	Lint Acre	Lint %	Bolls/ Lb.	% 1st Picking	Fiber Properties Staple	Mike
	lbs.	%	no.	%	1/32 in.	Index
ville 7A	763	41.3	83	94	34.6	5.4
King II	748	42.8	66	95	34.0	5.1
ck	733	42.4	74	96	33.6	4.9
ville 213	726	41.1	81	96	34.4	5.4
310	703	42.7	83	96	34.9	5.2
417	687	40.9	79	95	34.7	4.6
201	680	42.3	83	95	34.3	5.2
pine 16	672	40.7	83	95	34.5	5.1
pine 45A	647	41.1	85	93	34.3	5.2
verage	706	41.7	79	95	34.3	5.1

Cotton variety performance at the Central Station, State College, in 1971.

Variety	Lint/ Acre	Lint %	Bolls/ Lb.	% 1st Picking	Fiber Properties				
					Staple Length	Mike	Strength	2.5% Span	UR
	lbs.	%	no.	%	1/32 in.	Index	M.P.S.I.	In.	%
Coker 201	879	40.5	94	80	35.0	4.6	77	1.12	48
DES 67-213	875	41.4	81	81	35.3	5.0	86	1.13	50
Stoneville 603	871	43.3	89	78	35.3	4.9	82	1.14	49
Hancock	861	41.2	78	78	35.6	4.5	82	1.13	47
Hybee 200A	848	40.4	84	80	34.6	4.8	84	1.09	50
Hybee 100A	841	41.4	90	82	35.3	4.3	--	--	--
Deltapine 45A	837	40.9	91	77	35.0	4.6	83	1.15	50
Stoneville 213	824	41.1	92	77	35.3	4.5	75	1.09	49
Dixie King II	821	40.4	88	77	35.6	4.7	84	1.14	50
Deltapine 16	812	41.4	80	83	35.3	4.6	83	1.17	46
Coker 310	805	40.3	82	76	35.3	4.5	82	1.15	49
Coker 417	795	41.2	88	77	35.0	4.5	82	1.06	48
Deltapine 6225	786	42.3	88	81	35.0	4.6	83	1.02	49
Stoneville 7A	749	41.1	86	80	35.6	4.8	80	1.14	50
Average	828	41.2	86	79	35.2	4.6	81	1.11	48
L.S.D. @ .05	N.S.								
@ .01	N.S.								

Three-year averages, Central Station, State College, 1969-71.

Variety	Lint/ Acre	Lint %	Bolls/ Lb.	% 1st[1/] Picking	Fiber Properties				
					Staple Length	Mike	Strength	2.5% Span	UR
	lbs.	%	no.	%	1/32 in.	Index	M.P,S.I.	In.	%
Stoneville 213	773	38.9	82	77	34.8	4.6	80	1.12	48
Coker 201	760	39.1	84	80	34.4	4.3	83	1.11	47
Hancock	756	39.2	74	78	34.3	4.3	86	1.08	46
Deltapine 45A	749	39.1	81	87	34.8	4.6	83	1.12	48
Coker 310	732	38.8	79	76	35.4	4.4	85	1.17	47
Deltapine 16	731	38.4	86	83	35.2	4.3	80	1.15	46
Stoneville 7A	695	38.9	84	80	35.3	4.6	85	1.16	47
Coker 417	690	38.2	79	77	35.0	4.2	87	1.13	46
Dixie King II	663	38.2	71	77	34.5	4.3	86	1.10	47
Average	727	38.7	80	79	34.8	4.4	83	1.12	46

[1/] One year average, 1971.

Performance of experimental strains at the Central Station, State College, in 1971.

Variety	Lint/ Acre	Lint %	Bolls/ Lb.	% 1st Picking	Fiber Properties				
					Staple Length	Mike	Strength	2.5% Span	UR
	lbs.	%	no.	%	1/32 in.	Index	M.P.S.I.	In.	%
Deltapine 16	893	41.6	91	81	34.5	4.8	76	1.12	49
Lankart 611	822	39.5	68	90	34.0	4.4	72	0.98	48
Deltapine 652	741	43.9	98	85	35.0	5.2	77	1.04	49
La. Super Okra 2	710	41.5	93	89	35.0	4.6	83	1.08	47
La. Okra 5	690	40.6	90	82	35.5	4.7	83	1.08	48
La. Okra 2	672	41.4	94	86	35.5	4.5	90	1.11	49
St. 7A -Frego -Okra	659	40.3	88	82	35.0	4.8	86	1.10	49
Tamcot SP 37	640	41.1	93	86	34.0	4.4	73	1.07	45
Stoneville 213	485	41.6	84	77	35.5	5.3	81	1.09	48
La. Frego 2	435	40.7	86	81	35.0	5.2	84	1.07	47
DSR 6-19-66-61	391	40.8	73	80	34.0	4.4	76	1.04	47
Average	648	41.1	87	83	34.8	4.7	80	1.07	47
L.S.D. @ .05	285								
@ .01	N.S.								
C.V.	30.9%								

variety performance at the Pontotoc Branch Experiment Station, Pontotoc, soil, in 1971.

ety	Lint/ Acre	Lint %	Bolls/ Lb.	% 1st Picking	Fiber Properties Staple	Mike
	lbs.	%	no.	%	1/32 in.	Index
00A	427	42.3	90	85	35.0	4.7
10	389	40.5	85	86	35.6	4.7
ing 11	377	38.0	77	83	34.3	4.6
00A	363	37.7	91	83	35.3	5.0
17	354	37.7	85	80	35.0	4.4
01	352	39.9	80	85	35.0	4.7
ne 16	334	37.5	92	82	34.6	4.6
lle 213	331	37.3	83	84	34.3	5.1
lle 603	306	35.8	83	82	35.0	4.9
	286	38.2	79	83	34.0	4.6
213	263	36.0	91	84	34.0	4.5
ne 6225	246	39.1	96	74	35.0	4.8
lle 7A	244	38.3	88	78	34.6	4.9
ne 45A	241	37.5	87	80	34.6	4.8
rage	322	38.2	86	82	34.7	4.7
@ .05	64					
@ .01	85					
	17.2%					

ear averages, Pontotoc Branch Experiment Station, Pontotoc, on ridge 969-71.

ety	Lint/ Acre	Lint %	Bolls/ Lb.	% 1st[1/] Picking	Fiber Properties Staple	Mike
	lbs.	%	no.	%	1/32 in.	Index
01	654	42.0	81	85	34.1	4.9
ne 16	643	40.8	84	82	34.2	5.0
10	624	41.6	83	86	34.6	5.0
	620	41.3	75	83	33.3	4.7
17	614	39.8	80	80	34.4	4.5
lle 213	606	41.5	81	84	34.0	5.3
lle 7A	589	41.2	85	78	34.1	5.2
ing 11	581	40.6	68	83	33.6	4.9
ne 45A	574	40.7	84	80	33.7	5.1
rage	611	41.0	80	82	34.0	4.9

year average, 1971.

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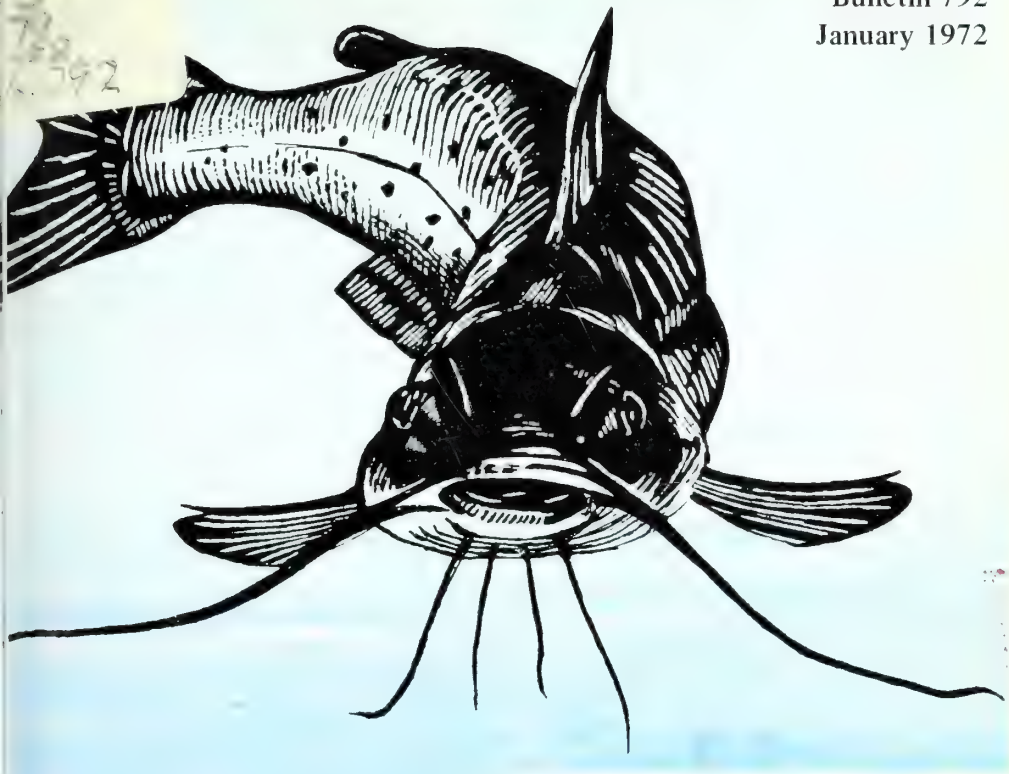

By Dr. Thomas H. Foster, Former Research Assistant and Dr. John E. Waldrop, MAFES Associate Economist

COST-SIZE RELATIONSHIPS IN THE PRODUCTION OF POND-RAISED CATFISH FOR FOOD

MISSISSIPPI STATE UNIVERSITY

AGRICULTURAL AND FORESTRY EXPERIMENT STATION

JAMES H. ANDERSON, Director

STATE COLLEGE MISSISSIPPI

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PREFACE

The research results reported in this Bulletin are based upon a research met d known as Economic-Engineering or Synthetic Firm Analysis. The method is ell suited to economic analysis of a relatively new industry such as the catfish industry

Research using these techniques relies heavily upon the cooperation of many a n- cies and experts in order to secure the required data. This study is no exception. W le it would be impossible to acknowledge each contributor to the study, the auth rs would like to acknowledge some major contributions and the cooperation of te following agencies and departments:

The Soil Conservation Service, State of Mississippi, provided invaluable informat n on pond design and specifications and the needed coefficients of pond construct n. Personnel of this agency were most helpful in the overall design of the study. Th ir assistance is greatly appreciated.

Personnel of the National Marine Fisheries Service Research Station, Rowl r, Arkansas, made available their research data on harvesting. Their cooperation as essential to the successful completion of the study.

Personnel in many departments of the Mississippi Agricultural and Forestry Exp i- ment Station and the Mississippi Cooperative Extension Service made very import nt contributions. For these contributions the authors wish to express sincere appre i- tion.

SUMMARY

The primary objective of this study to provide data on the costs of producing catfish associated with selected pond sizes in Mississippi. Such information should provide indications of the cost reductions available through a more efficient organization and use of production resources in the catfish enterprise under present technology.

Six pond sizes—5, 10, 20, 40, 80, and 160 acres—were selected for analysis. In consideration of "lumpy" or "indivisible" resources, a 160-acre square tract was selected as the land base. With pond size constant within a given farm, six farm situations were defined. These six farm situations were: (1) a simulated farm consisting of thirty-two 5-acre ponds (Farm Situation I); (2) a simulated farm consisting of sixteen 10-acre ponds (Farm Situation II); (3) a simulated farm consisting of eight 20-acre ponds (Farm Situation III); (4) a simulated farm consisting of four 40-acre ponds (Farm Situation IV); (5) a simulated farm consisting of two 80-acre ponds (Farm Situation V); and (6) a simulated farm consisting of one 160-acre pond (Farm Situation VI). Each Farm Situation was assumed to have the fulltime labor complement of two men—a qualified fish culturalist as manager and a hired laborer. Provisions were made for hiring additional labor at harvest.

Analyses of these six Farm Situations were accomplished by budgeting procedures. The economic-engineering and/or synthetic firm technique was employed to develop the input- output coefficients necessary for analysis. Coefficients were synthesized from available input-output data, recommendations from professional workers, observations from selected growers, and supporting material from agribusiness establishments.

High-level management was assumed as many of the top managers of catfish farms now operate some segments of their enterprises at this advanced level, and the performance assumed should be attainable for a large percentage of managers with adoption of the practices and recommendations employed.

The estimated initial investment decreased significantly on both a total and per surface acre of water basis as the size of the pond was increased—from roughly $216,000, or $1,730 per acre for the 5-acre pond system to about $141,000, or $947 per acre for a system using one 160-acre pond. Most of the economies of investment associated with size were attributable to pond construction costs. Investment in harvesting equipment was the only investment item that increased as pond size increased.

Total annual costs ranged from $89,682.72 for Farm Situation II to $98,351.53 for Farm Situation VI. Though Farm Situation II had the lowest annual total cost, Farm Situation III had the lowest cost per pound of harvested fish—26.62 cents. Costs per pound were highest—30.55 cents—in Farm Situation I.

Feed and fingerlings accounted for 39 to 45 percent of total costs with most other components accounting for four percent or less of total costs. In general a 10-percent change in the price of feed **ceteris paribus**, resulted in 0.7 cents change in cost per pound of output, and a 10-percent change in fingerling price changed per-unit cost of output by 0.5 cents.

At product prices ranging from $.26 to $.35 per pound Farm Situation III was most profitable of the Farm Situations studied. Farm Situation I was the least profitable. Net returns ranged from $28,333 to $3,205 at $.35 per pound and from -$2,105 to -$13,471 at $.26 per pound. All prices for fish were f.o.b. pond bank. Though Farm Situation III was most profitable, there were no substantial differences in the profitability of Farm Situations III, IV, and V.

COST-SIZE RELATIONSHIPS IN THE PRODUCTION OF POND-RAISED CATFISH FOR FOOD

by
Thomas H. Foster and John E. Waldrop*

he Mississippi commercial catfish in-ry has experienced rapid growth in last few years. In 1967, a canvass of state revealed that the industry con-d of 534 ponds flooding 4,658 acres produced 2,357,500 pounds of chan-atfish (28).[1]/Production statistics for state's 1969 "crop", the most recent available, identifies 17,972 acres ced for commercial catfish produc-Of this, 13,820 acres were devoted od fish with the remainder divided een fingerling production and brood-c. Total food fish production from 13,820 acres was estimated to be 21 on pounds (25).

he national catfish industry has ex-nced similar growth but this is axi-tic as Meyer, et al. (25, pp. 4-5)re-; that "Mississippi is the leading in the production of catfish" re-sible for approximately 40 percent ational production. It is estimated in 1963 there were 2,370 acres in sh nationwide and 1969 estimates d total acreage devoted to commer-catfish production at 39,300 acres

hile there are indications that the of growth of the industry may be easing, Greenfield (17, pp. 7-8) pre-catfish production to approach or ed 50,000 acres by 1972.

The Problem

oblems have emerged in all sectors ne industry—production, processing, marketing. Consumer resistance to resent supply price levels; inventory buildups; insufficient uniformity in product size, quality, and quantity to take advantage of institutional markets; and regional demand without established marketing channels are some of the more prominently mentioned problems that beset the industry (17,30). Prior to the 1970 harvest season, discussions with managers of processing facilities revealed that because of limited plant numbers and capacity, a significant number of producers would probably encounter some difficulty in obtaining a market for their 1970 production. Though no published price data are available, industry "talk" indicates that a seasonal "surplus" of fish did occur and prices received fell to possibly as low as 22.0 cents per pound. At the Mississippi Catfish Growers Convention held in Jackson, Mississippi in May, 1971, discussions centered about the topics of an expected "shortage" of catfish and the inadequacy of available data.

The catfish industry is characterized by a lack of reliable information not only with respect to production and marketing statistics but also in regard to production recommendations and economic planning. Point observations have been extrapolated into broad, sweeping recommendations on intensive commercial culture that are in fact contradictory on many points, thus rendering the information essentially useless as reliable planning data.

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[1]/Numbers in parentheses refer to number citation in the SELECTED REFERENCES.

While planning data and economic appraisal of practices and alternatives are needed in all sectors of the industry, the study will concentrate in only one—production. It is felt that the need for rigorous economic analysis in this area is critical. Reported per-unit production costs range from $.26 to $.46 per pound live weight (3, 13, 14, 17, 25, 32). Informed professional workers estimated that 1970-71 prices received by growers would range from $.30 to $.33 per pound (17, 30). As mentioned previously, reliable information indicates that winter 1970-71 prices did in fact fall to as low as $.22 per pound.

If these cost estimates and prices received as quoted are accurate some operators were faced with substantial losses on their operations, or will be in the near future if the price levels mentioned persist. An immediate adjustment problem faced by managers and/or planners is concerned with cost reductions available through a more efficient organization and use of production resources in the business enterprises under present technology. This study is directed toward this specific area.

Additionally, limited research funds are available for catfish production research. A rigorous economic analysis of the catfish production enterprise could supply information to aid in directing scarce research funds to those areas offering a high "payoff" potential.

Purpose and Objectives of the Study

The primary purpose of this study was to provide data on the costs of producing catfish associated with selected pond sizes in Mississippi.

The specific objectives were to:

(1) Identify relevant pond sizes for analysis.

(2) Develop input-output data or information necessary to examine the cost-size relationships.

(3) Develop and analyze per-unit costs for the pond sizes identified under (1) above.

(4) Determine the effect of price and tions for selected inputs c per-unit costs associated wi different size ponds analyzed

Method of Study

Budgeting procedures were emp to estimate and compare per-unit co producing catfish in ponds of dif sizes. The economic-engineeri synthetic firm methodology of cos mation was employed to combi sources and practices under a simila of management.

In consideration of the "lumpine certain inputs, a production land be 160 acres was defined. [2/] Pond siz lected for analysis were 5, 10, 20, 4 and 160 acres. Given the 160-acr base and the pond sizes considere systems or farm situations were de Each of these six situations are com entirely of ponds of one size. For ple, one farm situation consists of two 5-acre ponds.

Given the hypothetical firms budgeted, the input of resources an put of product were specified. output coefficients were synthesiz technical units of the catfish produ process from available input-output recommendations from profes workers, observations from se growers, and supporting material agri-business establishments.

Total costs were developed for t farm situations by applicati appropriate prices to the estimated cients. Costs were summarized into al operating costs, annual own costs, total costs, and total costs pe The importance of each component tal cost, the effect of input price tions on costs, and possible retu varying product prices were examine

[2/] This does not include the three a sumed to be needed for a service area, storage for feed, equipment, et cetera.

Meaningful cost estimates can only be ved in terms of an explicitly stated s. This "basis", "resource bundle" or m situation" is defined by the re- rces and production possibilities avail- to the firm, which in turn arise from assumptions embodied in the study. s section specifies the assumptions l, describes the resources available to firm, and describes coefficient devel- ent. [3/]

Assumptions Employed

n addition to the assumptions dic- d by the theoretical framework, cer- assumptions are required to identify synthetic firm for analysis. The cat- enterprise is assumed to be a separate ty and consistent with other farm s of present-day Mississippi agricul- . The firm(s) are constructed and op- ed as specialized wholesale "catfish food" producing units. The enterprise lesigned incorporates the most ad- ed technology and production prac- known but not necessarily adopted. s, the level of management is ad- ed but commensurate with levels cur- ly employed in some cropping and tock systems of the state.

roduction theory dictates that "inso- as possible production will take place he use of such a combination of fac- that the average returns to each sepa- ly will diminish (or at most remain stant) with an increase in the amount that factor used relative to the unts of other factors" **(11, p. 130)** vever, difficulty may be encountered confining the firm to the region of inishing returns because of the indi- ility of some input(s). In order to blish the firm size for this study a able, qualified firm manager was assumed to be the most "lumpy" or "indivisible" input. Based on cost estimates currently available it was assumed that 160 acres of land would be capable of paying the $13,000 to $16,000 annual salary deemed necessary to attract qualified management. Thus, 160 acres of land were employed to establish firm size for analysis. However, this should not be interpreted as the maximum land area a manager can effectively manage.

Additionally, land is assumed to be available in square, 160-acre units. Because of the uniqueness of the problem, a "typical" or "representative" land resource base cannot be identified as such—i.e., essentially infinite configurations are possible. In a practical sense this assumption is very realistic. Not only is the unit common in land transfers but it also identifies a research standard to which individual situations may be readily adjusted for comparison.

Given the land area of 160 acres, assumptions are required with respect to pond size [4/] in order to investigate cost reductions available through a more efficient organization and use of production resources. Pond sizes selected were: 5 acres; 10 acres; 20 acres; 40 acres; 80

[3/]Coefficient development in this section is general. For the detailed technical procedures used in developing coefficients see the Appendix.

[4/]Prevailing designation of ponds or production unit sizes in acreage is metaphoric and deceptive. For example, a reservoir constructed from a 10-acre tract of land with the full complement of levees and drainage structures will yield a reservoir with a surface water acreage of approximately 7 acres, depending on construction specifications. For the purposes of this study **pond size** refers to pond size in acres, including the supporting complement of levees and drainage structures.

acres; and 160 acres. The lower limit of 5 acres was determined on the basis on construction costs and other practical considerations. Through consultation with harvesting technique researchers it was determined that present harvesting logistics effectively sets the upper limit on pond size at 80 acres. The 160-acre size was selected for inclusion in the study so that potential technological developments in harvesting, levee stabilization, and pond configuration may be evaluated.

Employing the above criteria, six farm situations were simulated in order to identify economies associated with pond size. Within a given farm situation pond size is constant. These six farm situations are as follows: (1) a simulated farm consisting of thirty-two 5-acre ponds (Farm Situation I); (2) a simulated farm consisting of sixteen 10-acre ponds (Farm Situation II); (3) a simulated farm consisting of eight 20-acres ponds (Farm Situation III); (4) a simulated farm consisting of four 40 acre-ponds (Farm Situation IV); (5) a simulated farm consisting of two 80-acre ponds (Farm Situation V); and (6) a simulated farm consisting of one 160-acre pond (Farm Situation VI).5

A labor complement of two persons, a manager and a laborer, is assumed available to the firm. This labor complement is assumed to furnish sufficient manpower to satisfy the routine needs of feeding, water management, maintenance, et cetera. Provisions for hiring additional labor required for harvesting were made.

The Basic Management System

For the purposes of this study a management system is defined as a method or system of producing catfish in which the end product is of a specific kind—sa catfish for food. The specific syste method of production is defined b production practices employed, an associated requirement(s) and level performance. Though the componer the system will be discussed separate is necessary to present the basic inf tion employed in requirement and b formulation that applies to all Farm ations.

The basic production plan wa signed to produce a marketable foo in one growing season of 210 day pond or reservoir culture. Six-inch nel catfish fingerlings weighing one were assumed to be stocked on Mar at the rate of 2,000 per surface ac water. It was assumed that on Octob the fish are ready to harvest and av 1.25 pounds (20.0 ozs.) live-weig mortality rate of 5.0 percent of the nal stocking rate and a feed conve ratio of 1.6:1 on the gain were assu Thus, total production per surface achieved was 2,375.0 pounds of s product, or 1,900 fish.

The technical coefficients disc above are critical to this analysis an assumed to be constant for all pond and farm situations analyzed. The d tion and detailed discussion of these nical coefficients are presented in th pendix.

Formulation of Technical Unit Coefficients

For the purpose of this study th fish production process was divided six technical units: (1) pond con tion; (2) water supply; (3) feedin

5/Farm Situation title (in parenthesi be used in the remainder of this study.

ease, parasite, and weed control; (5) vesting; and (6) miscellanea. [6] This tion will be devoted to specification of coefficients of production for each nical unit.

nd Construction

Pond construction coefficients and s the resultant cost figures are influ- ed by a multiplicity of factors and ditions **(15)**. Paramount among these tors are: levee dimensions; pond size l configurations; and topography. The y nature of these factors precludes ctical establishment of a "typical situ- on" for analysis since essentially infi- e combinations are possible. Addition- , present recommendations with re- ct to pond design and levee construc- n offer considerable latitude, which npers the selection of any one design l associated specifications as the st" or "ideal."[7] In essence, then, d design and specifications are depen- t upon characteristics of the indi- ual firm (or hypothetical firm as in s study) and the source of professional nning service.

For the purpose of this study, the pro- ional planning services of the Soil nservation Service, State of Mississippi, e requested and obtained. Soil Conser- on Service records reveal that this or- ization has designed and supervised struction of, or has furnished profes- nal assistance for, the vast majority of catfish farms currently in operation in sissippi. The following design specifi- ons are the results of consultations h Soil Conservation Service personnel. All levees employed in this study have ourteen-foot crown, 3:1 side slopes, a y-foot base, and are designed to maintain a minimum water depth of four feet with a two-foot free-board.[8] Sufficient crown is graveled to permit all-weather access. The 160-acre tract is bordered on two opposite sides by drainage structures. These ditches are of standard dimensions with a three-foot bottom and a twelve-foot top. An eight-foot berm between the base of the levees and these drainage structures is incorporated in the design. Sketches of pond arrangements for each Farm Situation studied and a detailed discussion of the derivation of technical coefficients are presented in the Appendix.

Pond size in surface acres, number of ponds per Farm Situation, and total surface acres of water per Farm Situation as developed from these specifications are summarized in Table 1.

Water Supply

Not only is water the medium of growth in the catfish production process but it is also the single most important management tool available to the fish farmer. Thus, selection of a water source and the capability of the supply system involves considerations other than establishment and maintenance of a minimum

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[6] It is obvious that these units are general. However, in view of the limited data on the catfish enterprise with respect to conversion rates of resource and factor substitution it is believed that delineation of additional technical units would be superfluous.

[7] Research to identify optimum or near optimum pond configuration, levee specification, etc. for various sets of resource and other restriction is needed. However, it is beyond the scope of this study and may be premature at the current stage of development of the catfish industry.

[8] Actual water depth will likely approach 5 feet on the average.

quantity of water deemed to be biologically necessary. Quantification of such considerations becomes exceedingly difficult because of problems encountered in defining the "typical situation." Because of these problems of quantification, at a minimum the restriction considered most limiting must be met. Given the high level of management required by the model employed in this study the most restrictive consideration in selecting a given water system is assumed to be the capability to deliver adequate supplies of fish water to meet management needs in stress periods.

Table 1. Estimated surface acres per pond and total per Farm Situation.

ITEM	Farm Situation					
	I	II	III	IV	V	VI
Surface acres per pond	3.9	8.5	17.8	36.4	73.5	148
Number of ponds per Farm Situation	32	16	8	4	2	1
Total number of surface acres per Farm Situation	124.8	136.0	142.4	145.6	147.0	148

Wells were assumed as the water source with a 100 g.p.m.[9/] per acre minimum flow requirement used for planning purposes. Wells with rated capacities of 2,000 and 3,000 g.p.m. with diesel power units were considered as water supply alternatives. The size and number of wells per given Farm Situation were selected on the basis of minimum flow restrictions and least cost criterion and are summarized in Table 2. Derivation of these technical coefficients are detailed in the Appendix.

Feeding

Use of a high quality extruded pellet feed is assumed. The fish are assumed to be fed with a 1,500-pound capacity, p.t.o. driven mechanical feeder. Provisions for bulk storage and handling of feed were considered in coefficient development.

Assumptions of the basic management system established total feed fed per harvested fish at 1.9 pounds or 3,610.0 pounds of feed per surface acre of water. The total quantities of feed in tons needed annually per Farm Situation are as follows:

9/ g.p.m. is the accepted abbreviation for "gallons per minute" and will be so used throughout this study.

rm Situation	Tons of Feed Used
I	225.26
II	245.48
III	257.03
IV	262.81
V	265.34
VI	268.22

A detailed discussion of the derivation the above technical coefficients and se associated with supporting comple- nt of equipment can be found in the ppendix.

ease, Parasite, and Weed Control

Coefficients and subsequently devel- d costs for disease, parasite, and weed itment and prevention can only be ex- ssed in terms of an explicitly stated is. For a detailed discussion of the es used in estimating disease, parasite, weed control coefficients and the sequently developed coefficients see Appendix.

rvesting

The harvesting system selected is the echanized haul seine technique" as de- oped at the National Marine Fisheries vice Gear Research Station, Rowher, ansas. The system has been adopted a large number of fish farmers and has ven functional over a variety of sizes properly constructed ponds **(6)**. Since original release of the technique, several equipment modifications and techniques have been developed **(2, 18)**. The system employed in this study includes the latest developments in equipment design and seine hauling procedure.

The development of coefficients associated with harvesting operation is presented in the Appendix.

Miscellanea

Coefficients associated with certain inputs cannot be allocated to other technical units without arbitrary assignment. Characteristically such inputs are utilized in two or more technical units and/or are more applicable to the entire operation than to a given production phase. Treatment of these inputs as a separate technical unit facilities discussion and serves as an aid in the identification of all costs associated with the enterprise.

Items included in this technical unit are: service and storage buildings; specified transportation, power, and general maintenance equipment; taxes; insurance; and general office overhead. The development of coefficients associated with this unit is detailed in the Appendix.

Table 2. Estimated number of wells by size and feet of pipe required to satisfy water requirements, by Farm Situation.

FARM SITUATION	Size of Wells		Discharge Pi in Feet
	3,000 g.p.m.	2,000 g.p.m.	
	No.	No.	lin. ft.
I	4	1	1,800.0
II	4	1	954.0
III	5	-	264.0
IV	5	-	204.0
V	5	-	136.0
VI	5	-	85.0

ESTIMATED INVESTMENT REQUIREMENT AND ANNUAL COSTS FOR THE SPECIFIED FARM SITUATIONS

iven the technical production coeffi-
s, the accuracy of costs calculated is
ndent upon the selection of appro-
e prices and procedures employed.
prices and methods of cost calcula-
are next presented, and followed by
ated investment requirements, annu-
sts for each of the six Farm Situa-
studied, and the sensitivity of costs
ice variations for specified inputs.

Specification of Prices and Cost Calculations

onventional budgeting procedures
ly employ historical prices of a spe-
l period as the choice of prices to use
luing inputs. Such a procedure is not
cable to the catfish industry—i.e.,
ndustry is "new" and requires spe-
ed inputs on which historical price
are not available. These prices used,
ndix Table 13, were a synthesis of
ier quotations, written and oral, for
and 1971.

he production and management pro-
assumes the manager to be a profi-
commercial catfish culturalist. It
ssumed that the fulltime services of
dividual meeting the above qualifica-
can be secured for an annual salary
4,500.00. The other component of
ulltime labor complement, the hired
er, was assumed to receive an annual
of $4,200.00. Labor hired to assist
g harvesting was paid the average
rate of $1.65 per hour.

he land utilized in the study was val-
at $260.00 per acre, the estimated
ge value per acre for the State of
ssippi in 1971 as reported by the
).A. (32).

Interest at a rate of 8 percent was charged on one-half of the original investment in depreciable items and at 9 percent on one-half of the estimated operating costs. Non-depreciable items, land and land improvements (ponds)[10/], were charged at an interest rate of 8 percent of the full inventory value.

Depreciation on all other equipment and facilities was calculated by the straight-line method. Repairs and maintenance were computed from estimates of average repairs for the life of the input as a percentage of the purchase price. Estimates with respect to estimated life, repairs and maintenance costs, and fuel consumption, were adapted from manufacturers' specifications, local dealer estimates, grower estimates, and other published material. The basic data employed and the resultant cost coefficients developed for facilities and equipment are presented in Appendix Table 14.

Investment Requirements

The initial investment requirements are based on equipment and facility re-

10/ Conventional practice in calculating costs of the catfish enterprise is to depreciate pond construction costs over some estimated life. In this context, annual depreciation cost is based on the contention that ponds will "wear out" or decline in productive capacity over the specified time period. Insufficient observations are available to establish the life of ponds or the amount of the decrease in productive capacity, if any. Ponds can be considered a durable asset. Therefore, if the durable is non-depreciable, investment in such an input is not a cost but rather the interest imputed to such input is a cost (8, pp. 170-171).

quirements as developed earlier in this report and in the Appendix. Estimated investment requirements for each Farm Situation, on both total and per-surface-acre-of-water bases, are shown in Table 3. It should be pointed out that the investment requirements as developed are directly related to the levee specifications and arrangement and configuration of ponds in each Farm Situation as defined for this study. Caution must be exercised in extrapolation of the data to seemingly similar situations.

The estimated initial investment, on both a total and a per-surface-acre-of-water basis, decreased significantly as the size of the ponds increased. Total requirements declined steadily from $215,929 for Farm Situation I to $140,757 for Farm Situation VI. Investment per surface acre of water declined steadily from $1,730.20 for Situation I to $947.22 for Situation VI.

The reasons for the decrease in investment with increases in pond size can be illustrated by considering each component of investment. Most of the economies of investment associated with size are attributable to pond construction. Given the pond design for each Farm Situation, the volume of earth moved per surface acre of water decreases rapidly as the size of the pond increases–i.e. fewer linear feet of levee are required. Likewise, drainage structures, amount of gravel required, and surface area requiring vegetative cover decreases as pond size increases (Appendix Tables 2 and 3).

Economies of investment in water supply as pond size increases are modest. Only two discrete pump sizes were considered as reasonable water supply alternatives. Investment requirements in wells alone are approximately the same with Farm Situation I and II having lower initial well investment than Situations III – VI (Appendix Table 19). However, the cost of pipe required to distribute
decreases significantly with increa
the size of pond. The decrease in
more than offsets differences in w
vestment.

Investment requirements for
components–Feeding; Disease, Pa
and Weed Control; and Miscellanea-
assumed to be constant for all six
Situations. On a per surface acre of
basis these components also afford
est economies of investment as pon
increases due to the differences in s
areas in each Farm Situation.

Investment in harvesting equipm
the only item that increases as the s
pond increases. Not only additional
but also additional mechanical an
port equipment is required to harve
large ponds (Appendix Tables 25-30

Annual Cost Analysis

Annual costs for the six Farm
tions are based on the input re
ments, prices, and procedures for co
plication as presented above and i
Appendix. Proper interpretation of
data can be made only in considerat
the total framework of this analysis.

Total annual costs were $90,5
$89,682.72, $90,036.92, $92,7
$93,878.21, and $98,351.74, for
Situations I, II, III, IV, V, and VI, r
tively. Costs per pound of harveste
fish were .3055, .2777, .2662, .
.2689, and .2787 dollars for Farm
tions I – VI, respectively (Tabl
Though Farm Situation II had the l
total cost, Farm Situation III ha
lowest cost per pound of any system
increases in production capability
face ares of water) made possible
increase in pond size from 10 acres (
Situation II) to 20 acres (Farm Situ
III) more than offset the increase in

ITEM	Farm Situation					
	I	II	III	IV	V	VI
	Dollars					
Land	42,380.00	42,380.00	42,380.00	42,380.00	42,380.00	42,380.00
Pond Construction (Earth moving, drainage structures, gravel and vegetative cover)	102,670.61	61,588.40	39,881.01	31,778.41	26,133.90	21,041.08
Water Supply (Wells and discharge pipe)	43,610.00	41,072.00	40,242.00	40,062.00	39,858.00	39,750.00
Feeding (Feeder and bulk storage)	1,950.00	1,950.00	1,950.00	1,950.00	1,950.00	1,950.00
Disease, parasite and weed control	1,190.00	1,190.00	1,190.00	1,190.00	1,190.00	1,190.00
Harvesting	6,902,00	7,391.00	8,652.00	12,615.00	13,119.00	17,265.00
Miscellaneous	17,226.00	17,226.00	17,226.00	17,226.00	17,226.00	17,226.00
Total Investment	215,928.61	172,797.40	151,521.01	147,201.41	141,856.90	140,757.08
Investment per surface acre of water						
Exclusive of land	1,390.61	958.95	766.44	719.93	676.71	662.03
Inclusive of land	1,730.20	1,270.57	1,064.05	1,011.00	956.01	947.22

Table 4. Estimated annual costs of producing catfish for food by pond culture for specified Farm Siuations, Mississippi 1971.

ITEM	Farm Situations					
	I	II	III	IV	V	VI
	Dollars					
Annual Ownership Costs:						
Interest on land investment	3,390.40	3,390.40	3,390.40	3,390.40	3,390.40	3,390.40
Interest on ponds and drainage structures	7,180.38	4,231.64	2,664.18	2,019.33	1,650.49	1,329.39
Depreciation						
Pond construction (gravel and vegetative cover)	2,583.17	1,738.58	1,315.76	1,307.36	1,100.57	884.75
Water supply (wells and discharge pipe)	3,823.35	3,696.45	3,702.95	3,693.95	3,683.75	3,676.10
Feeding (feeder and storage)	195.00	195.00	195.00	195.00	195.00	195.00
Harvesting equipment	612.60	728.70	945.40	1,556.00	1,628.80	2,401.00
Disease, parasite and weed control equipment	155.50	155.50	155.50	155.50	155.50	155.50
Miscellaneous equipment	1,670.58	1,670.58	1,670.58	1,670.58	1,678.58	1,670.58
Interest on investment						
Pond construction (gravel and vegetative cover)	516.63	347.72	263.15	261.47	220.11	176.95
Water supply (wells and discharge pipes)	1,744.40	1,642.88	1,609.68	1,602.48	1,594.32	1,588.20
Feeding equipment (feeder and storage)	78.00	78.00	78.00	78.00	78.00	78.00
Disease, parasite and	47.60	47.60	47.60	47.60	47.60	47.60

Mississippi, 1971 (Continued)

ITEM	Farm Situation					
	I	II	III	IV	V	VI
	Dollars					
Miscellaneous equipment	801.54	801.54	801.54	801.54	801.54	801.54
Sub-Total	23,071.27	19,019.93	17,185.82	17,287.01	16,737.42	17,079.21
Annual Operating Costs:						
Repairs and Maintenance						
Ponds	396.47	288.09	232.25	206.21	192.61	178.30
Water supply	1,146.30	1,146.30	1,183.50	1,183.50	1,183.50	1,183.50
Feeding equipment	130.00	130.00	130.00	130.00	130.00	130.00
Disease, parasite and weed control	65.48	65.48	65.48	65.48	65.48	65.48
Harvesting equipment	336.85	364.85	431.85	649.25	649.25	851.75
Miscellaneous equipment	1,635.15	1,635.15	1,635.15	1,635.15	1,635.15	1,635.15
Fuel						
Pumping	3,808.85	4,150.27	4,437.81	4,537.54	4,581.17	4,631.03
Power, transportation, feeding, harvest, etc.	1,249.76	1,249.76	1,249.76	1,276.64	1,276.64	1,276.64
Chemicals	714.36	765.28	798.86	1,326.79	2,574.36	5,215.77
Fingerlings	14,976.00	16,320.00	17,088.00	17,472.00	17,640.00	17,832.00
Feed	20,273.40	22,093.20	23,132.70	23,652.90	23,880.60	24.139.80
Labor						
Manager	14,500.00	14,500.00	14,500.00	14,500.00	14,500.00	14,500.00
Hired laborer (full-time)	4,200.00	4,200.00	4,200.00	4,200.00	4,200.00	4,200.00
Hired laborer for harvest	1,297.30	927.17	874.76	1,704.38	1,616.11	2,222.80

Continued

Table 4. Estimated annual costs of producing catfish for food by pond culture for specified Farm Situations, Mississippi, 1971. (Continued)

ITEM	I	II	III	IV	V	VI
	----------Dollars----------					
Taxes, insurance, bookkeeping, general office overhead	769.10	769.10	769.10	769.10	769.10	769.10
Sub-Total	65,499.02	68,604.65	70,729.22	73,308.94	74,893.97	78,831.32
Interest on operating capital	1,964.97	2,058.14	2,121.88	2,199.27	2,246.82	2,441.21
Total annual operating costs	67,463.99	70,662.79	72,851.10	75,508.21	77,140.79	81,278.53
Total Costs	90,535.26	89,682.72	90,036.92	92,795.92	93,878.21	98,351.74
Total Production (pounds)	296,400.0	323,000.0	338,200.0	345,800.0	349,125.0	352,925.0
Cost per pound	.3055	.2777	.2662	.2683	.2689	.2787

Annual ownership costs[11/] tend to de-
ne as pond size comprising a given
rm Situation is increased from 5 acres
160 acres. The economies observable
annual ownership costs are explainable
those factors previously associated
th investment economies.

With respect to annual operating costs,
e reverse was observed. As pond size is
creased, total annual operating costs are
creased. Most of this increase is directly
lated to and explainable by the varia-
n in total surface acreage of water per
rm Situation (Table 1).

Examination of annual operating cost
mponents can isolate other factors that
ntribute to the increase in total oper-
ing costs as pond size is increased. Pond
pair and maintenance reflected modest
onomies associated with increases in
nd size. Each successive increase in
nd size studied requires fewer total lin-
r feet of levee. For the pond sizes
idied those costs were observed to de-
ase at a decreasing rate. Diseconomies
sociated with increases in pond size
re observed in water supply, harvesting
uipment repair and maintenance, chem-
ls, and hired labor for harvest.[12/] The
seconomies associated with water sup-
y are negligible. This is not surprising
nsidering the water supply alternatives
sumed for this study. Diseconomies ob-
rvable with respect to harvest equip-
ent repair and maintenance are modest
d underscore the additional equipment
quired for harvesting as pond size is in-
eased (Appendix Tables 25-30).

The increases in chemical cost asso-
ated with increases in pond size are sub-
antial. Over the pond sizes studied these
sts increased at an increasing rate.
ven the assumption that the incidence
disease, parasite or weed infections oc-
rs in isolated ponds rather than in all
nds it is axiomatic that the cost of chemicals will increase with increases in pond size (Appendix Table 4).

The increase in the costs of hired labor for harvest as pond size increases is related to two factors. First, the number of workers required to perform the seining operations increases. Second is the increase in hired labor required for overnight maintenance of fish if production per pond exceeds 20,000 pounds—the assumed restriction on the maximum harvest allowed per day. This latter factor is related to pond size but it underscores the logistical problem of transporting harvested fish currently confronting the industry.

Estimated total, annual ownership, and annual operating costs per pound of harvested catfish associated with each pond size are presented graphically in Figure 1. Since these per unit costs were derived directly from the totals mentioned above, the plausible factors identified earlier as contributing to both economies and diseconomies associated with ponds are applicable and need not be reiterated. However, the graphic analysis brings into sharp focus the cost-size relationships discovered in this study. Also, it allows rapid interpretation of the effects of alternative product prices.

Annual operating costs were 21.5 cents per pound for Farm Situation III

11/Annual ownership costs as calculated here are frequently designated as "non-cash fixed costs." Annual operating costs as calculated are frequently designated as "out-of-pocket costs." Taxes are included in annual operating costs to facilitate accounting procedures.

12/Those increases in costs observable in fuel for pumping, fingerlings, and feed are related to the increase in surface acreage associated with Farm Situations I-VI. These relationships are not diseconomies associated with pond size.

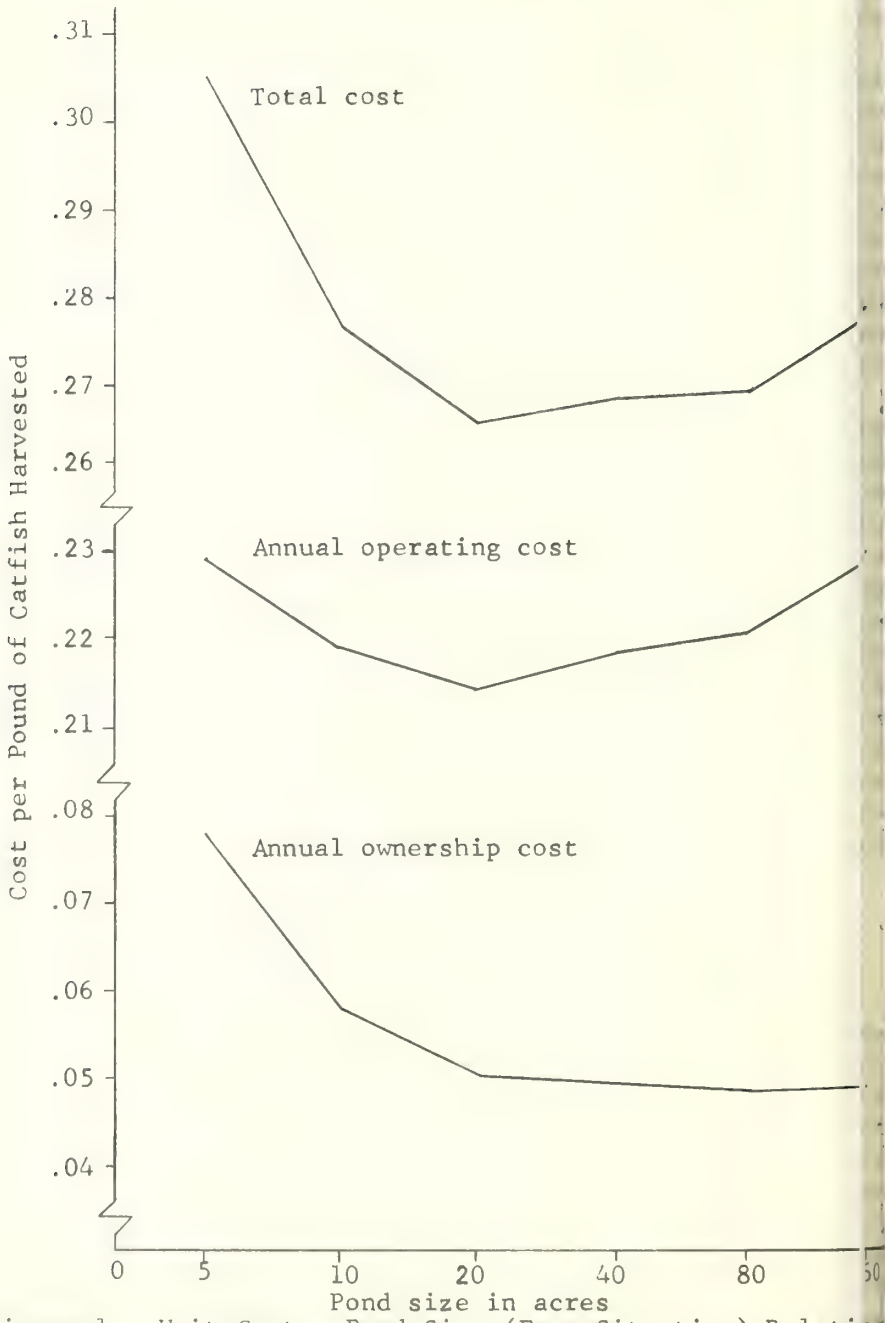

Figure 1. Unit Cost - Pond Size (Farm Situation) Relationships*. */Costs associated with each size based on 160 acres of land devoted to each size.

l from 0.3 to 1.5 cents per pound
her for the other five Situations.

At prices above per unit annual operaig cost but below per unit total cost it uld be feasible to continue to produce ler all Farm Situations until prices imve or until liquidation of the firms is sible. If charges for land and for manr's labor are not considered (ownerager unit), continued production at ificantly lower prices would be a ra-nal decision under similar time re-ints.

Estimated annual cost components exssed as percentage of total costs are sented in Table 5. Note that in all m Situations studied, fingerlings, feed, the manager's salary account for 55 61 percent of total costs. Since no er component of any Farm Situation ounts for more than 7.93 percent (inest on ponds and drainage construction Farm Situation I), and most compots account for four percent or less of al costs, it would appear that efforts to ce substantial reductions in productn costs should be concentrated on the t of feed and fingerlings. 13/

Cost Sensitivity

For purposes of analysis the price of d was set at $90 per ton and the price fingerlings at six cents each. To meae the sensitivity of production costs to nges in the prices of these inputs, ces of feed and of fingerlings were ied by 10, 20, and 30 percent from se bases. Generally, when prices of er inputs are constant, each 10 per-t change in feed prices results in a en-tenth cent change in cost per pound fish harvested, and a corresponding nge in fingerling prices, **ceteris paribus**, brings forth a half-cent a pound change in product cost, Tables 6 and 7. Changes of these magnitudes in costs per unit tend to conceal the significance of this observation. Data in Tables 8 and 9 show the effects of variation in feed and fingerling costs expressed as a net change in returns to entrepreneurship in dollars per acre of land. On this basis effects are more readily observed. For example, in Farm Situation III a 10 percent reduction in feed costs or fingerling costs increases net return per acre of land by $14.52 and $10.37, respectively, under the conditions assumed for this analysis.

The effects of price variations of both inputs—feed and fingerlings—are pronounced. Attempts to increase efficiency and reduce costs must consider the influence on total costs of these two inputs.

Returns

In order to calculate returns to the "catfish for food" enterprise some product price must be selected. Conventional price specification for budgeting centers about historical data—either using the actual prices of a former period which the future is assumed to resemble or future prices as developed from historical series with trends **(9, pp. 26-30)**. However, there are no published price data available on catfish for food and assuming any one price would be purely arbitrary. In order to assess the profitability of the Farm Situations studied, returns were calculated for a range of catfish prices—26 to 35 cents per pound (f.o.b. pond levee), Table 10. This range roughly corresponds to

13/ Reducing the cost of management is not an alternative in this study since all costs computed are based on a level of management that has a cost set by assumption.

Table 5. Estimated annual cost components expressed as a percent of total costs by specified Farm Situations, Mississippi, 1971.

ITEM	Farm Situation					
	I	II	III	IV	V	VI
	Percent					
Annual Ownership Costs:						
Interest on land investment	3.74	3.78	3.77	3.65	3.61	3.45
Interest on ponds and drainage construction	7.93	4.72	2.96	2.18	1.76	1.35
Depreciation:						
Pond construction	2.85	1.94	1.46	1.41	1.17	.90
Water supply	4.22	4.12	4.11	3.98	3.92	3.74
Feeding equipment	.22	.22	.22	.21	.21	.20
Harvesting equipment	.68	.81	1.05	1.68	1.74	2.44
Disease, parasite and weed control equipment	.17	.17	.17	.17	.17	.16
Miscellaneous equipment	1.85	1.86	1.86	1.80	1.78	1.70
Interest on investment:						
Pond construction	.57	.39	.29	.28	.23	.18
Water supply	1.93	1.83	1.79	1.73	1.70	1.61
Feeding equipment	.09	.09	.09	.08	.08	.08
Disease, parasite and weed control equipment	.05	.05	.05	.05	.05	.05
Harvesting equipment	.30	.33	.38	.55	.55	.70
Miscellaneous equipment	.89	.89	.89	.86	.85	.81
Annual Operating Costs:						
Repairs and maintenance						
Ponds	.44	.32	.26	.22	.21	.18
Water supply	1.27	1.29	1.31	1.27	1.26	1.23
Feeding equipment	.14	.13	.14	.14	.14	.13

Table 5. Estimated annual cost components expressed as a percent of total costs by specified farm situations [illegible] (continued)

ITEM	Farm Situation					
	I	II	III	IV	V	VI
	Percent					
Disease, parasite and weed control equipment	.07	.07	.07	.07	.06	.07
Harvesting equipment	.37	.41	.48	.69	.69	.87
Miscellaneous equipment	1.81	1.82	1.82	1.76	1.74	1.66
Fuel:						
Pumping	4.21	4.63	4.93	4.88	4.88	4.71
Power, transportation, feeding, harvest, etc.	1.38	1.39	1.39	1.38	1.36	1.30
Chemicals	.79	.85	.89	1.43	2.74	5.30
Fingerlings	16.54	18.20	18.98	18.83	18.79	18.13
Feed	22.39	24.63	25.69	25.49	25.44	24.54
Labor:						
Manager	16.02	16.17	16.10	15.63	15.45	14.73
Hired labor (full-time)	4.64	4.68	4.66	4.53	4.47	4.27
Hired labor for harvest	1.43	1.03	.97	1.84	1.72	2.26
Taxes, insurance, bookkeeping, general office overhead	.85	.86	.85	.83	.82	.78
Interest on operating capital	2.17	2.29	2.36	2.37	2.39	2.48
Total	100.0	100.0	100.0	100.0	100.0	100.0

Table 6. Total cost per pound of harvest catfish at selected feed prices, ceteris paribus, by Farm Situation.

Price per Ton of Feed	Farm Situation					
	I	II	III	IV	V	VI
	Dollars					
63.00	.285	.257	.245	.247	.248	.258
72.00	.292	.264	.252	.254	.255	.265
81.00	.299	.271	.259	.261	.262	.272
90.00[1/]	.306	.278	.266	.268	.269	.279
99.00	.313	.285	.273	.275	.276	.286
108.00	.320	.292	.280	.282	.283	.293
117.00	.327	.299	.287	.289	.290	.300

[1/] $90.00 per ton of feed was the price assumed in budget development. Other prices are 10, 20, and 30 percent deviations both above and below the $90.00 per ton base price.

Table 7. Total cost per pound of harvested catfish at selected fingerling prices, ceteris paribus, by Farm Situation.

Price per Fingerling	Farm Situation					
	I	II	III	IV	V	VI
	Dollars					
.042	.291	.263	.251	.253	.254	.264
.048	.296	.268	.256	.258	.259	.269
.054	.301	.273	.261	.263	.264	.274
.060[1/]	.306	.278	.266	.268	.269	.279
.066	.311	.283	.271	.273	.274	.284
.072	.316	.288	.276	.278	.279	.289
.078	.321	.293	.281	.283	.284	.294

[1/] $.06 [illegible] deviation both above and below the $.06 per fingerling price.

Table 8. Net effect in dollars per acre of land on returns to entrepreneurship due to specified variations in feed costs, by Farm Situation.

Percentage Change in the Base price of Feed[1/]	Farm Situation					
	I	II	III	IV	V	VI
	Dollars					
±10.0	±12.73	±13.87	±14.52	±14.85	±14.99	±15.16
±20.0	±25.46	±27.74	±29.04	±29.70	±29.98	±30.32
±30.0	±38.19	±41.61	±43.56	±44.55	±44.97	±45.58

[1/] Base price of feed = $90.00 per ton.

Table 9. Net effect in dollars per acre of land on returns to entrepreneurship due to specified variations in fingerling costs, by Farm Situation.

Percentage Change in the Base Price of Fingerlings[1/]	Farm Situation					
	I	II	III	IV	V	VI
	Dollars					
±10.0	± 9.09	± 9.91	±10.37	±10.61	±10.71	±10.83
±20.0	±18.18	±19.82	±20.74	±21.22	±21.42	±21.66
±30.0	±27.27	±29.73	±31.11	±31.83	±32.13	±32.49

[1/] Base price of fingerlings = $.06 each.

oral quotations obtained from producers and processors. The most frequently quoted prices ranged from 30.0 to 33.0 cents.

Total costs are presented earlier included payments to all resources used in production. If, in fact, the costs as charged are the true opportunity costs of the resources as assumed, these payments are large enough to keep the resources employed in the enterprise. As long as returns are equal to or greater than total costs, as defined above, profit maximizing entrepreneurs will not consider shifting the resources to alternative enterprises. The returns to entrepreneurship or profits represent a surplus of earnings after the payment for all resources used at their opportunity costs (8, pp. 26-27).

At prices of $.26 to $.35 per pound in one-cent intervals, Farm Situation III (utilizing 20-acre ponds) was the most profitable of the six Farm Situations analyzed (Table 10). For Farm Situation III, total returns to entrepreneurship ranged from $28,333 at 35 cents per pound to a loss of $2,105 at 26 cents per pound. For the same Farm Situation, profits per acre of land range from $173.82 at 35 cents per pound to -$12.91 at 26 cents per pound. Farm Situation I (5-acre ponds) was the least profitable of all the Farm Situations analyzed. At prices of 35 cents per pound, the highest product prices considered, total profits were $13,204.74 and profits per acre of land $81.01. Below product prices of 31 cents, a rational manager should not commit his resources to production under the assumed conditions for Farm Situation I.

Though Farm Situation III had the highest returns to entrepreneurship of all the Situations studied, there is in fact no substantial difference in the profitability of Farm Situations III, IV, and V. Only these three situations yield positi turns to entrepreneurship at a price cents per pound, and even they sh losses when the price was dropped cents.

If in fact prices received for catfi cur within the upper portion of the considered and costs similar to identified in this study are achieve "catfish for food" enterprise can be c tive.

If the entrepreneur is the manag owner of the land, he may consid opportunity costs of these factors zero. Under such circumstances, the of these items are removed from costs, and any excess of gross r above costs exclusive of the manage ary and land charges are referred "returns to land, management, entrepreneurship." Using this as a surement of returns, the entrepreneu then decide whether or not the ret satisfactory to him (8, p. 26). The r to land, management and entrepre ship as calculated for Farm Situati VI at selected product price levels ar sented in Table 11.

Interpretation of the return mea must be made with caution. An im assumption embodied in the figu that the entrepreneur does in fact sufficient managerial skill as a fish c alist to achieve those levels of p mance considered when the initial coefficients were developed. Additio the manager is assumed to own the If either of the assumptions hold, s measure of returns is not the rel criteria for making decisions with re to the enterprise under consideratio

14/For example, the annual net cash might not be sufficient to amortize the i ment if one of these units were purchas loan.

Table 10. Total and per acre annual returns to entrepreneurship at selected price levels, by Farm Situation.1/

ITEM	Farm Situation					
	I					
	Dollars					
Total Net Returns at Prices of:						
.35 per pound	13,204.74	23,367.28	28,333.08	28,234.78	28,315.54	25,172.01
.34 per pound	10,240.74	20,137.28	24,951.08	24,776.78	24,824.29	21,642.76
.33 per pound	7,276.74	16,907.28	21,569.08	21,318.78	21,333.04	18,113.51
.32 per pound	4,312.74	13,677.28	18,187.08	17,860.78	17,841.79	14,584.26
.31 per pound	1,348.74	10,477.28	14,805.08	14,402.78	14,350.49	11,055.01
.30 per pound	- 1,615.26	7,217.28	11,423.08	10,944.78	10,859.29	7,525.76
.29 per pound	- 4,579.26	3,987.28	8,041.08	7,486.78	7,368.04	3,996.51
.28 per pound	- 7,543.26	757.28	4,659.08	4,028.78	3,876.79	467.26
.27 per pound	-10,507.26	- 2,472.72	1,277.08	570.78	385.54	- 3,061.99
.26 per pound	-13,471.26	- 5,702.72	- 2,104.92	- 2,887.22	- 3,105.70	- 6,591.24
Net Returns per acre of land at prices of:						
.35 per pound	81.01	143.41	173.82	173.22	173.71	154.43
.34 per pound	62.83	123.54	153.07	152.00	152.30	132.78
.33 per pound	44.64	103.73	132.33	130.79	130.88	111.13
.32 per pound	26.46	83.91	111.58	109.58	109.46	89.47
.31 per pound	8.26	64.09	90.82	88.36	88.04	67.82
.30 per pound	- 9.91	44.28	70.08	67.15	66.62	46.17
.29 per pound	- 28.09	24.26	49.33	45.93	45.20	24.52
.28 per pound	- 46.28	4.63	28.58	24.72	23.78	2.87
.27 per pound	- 64.46	- 15.17	7.83	3.50	2.37	- 18.79
.26 per pound	- 82.65	- 34.99	- 12.91	- 17.71	- 19.05	- 40.44

1/The appropriate pounds of fish produced and the associated costs are presented in Table 4, p. 25.

Table 11. Annual returns to land, management, and entrepreneurship at selected price levels by Farm Situation, 1971.

ITEM	Farm Situation					
	I	II	III	IV	V	VI
	Dollars					
Total Specified Costs (excluding land charges and manager's salary)	17,774.86	70,922.32	71,276.52	74,034.87	75,117.81	80,461.40
Total Returns to Land, Management and Entrepreneurship at prices of:						
$.35 per pound	31,965.14	42,127.68	47,093.48	46,995.13	47,075.95	43,062.35
.33 per pound	26,037.14	35,667.68	40,329.48	40,079.13	40,093.34	36,003.85
.30 per pound	17,145.14	25,977.68	30,183.48	29,705.13	29,619.59	25,412.25
.28 per pound	11,217.14	19,517.68	23,419.48	22,789.13	22,637.09	18,353.75
.26 per pound	5,289.14	13,057.68	16,655.48	15,873.13	15,654.59	11,295.25
.24 per pound	- 638.86	6,597.68	9,891.48	8,957.13	8,672.09	4,236.75
.22 per pound	- 6,566.86	137.68	3,127.48	2,041.13	1,689.59	- 2,821.75
.20 per pound	-12,494.86	- 6,322.32	- 3,636.52	- 4,874.87	- 5,292.91	- 9,880.25
Returns to Land, Management, and Entrepreneurship per acre at prices of:						
.35 per pound	196.11	258.45	288.92	288.31	288.80	264.19
.33 per pound	159.74	218.82	247.42	245.88	245.97	220.88
.30 per pound	105.18	159.37	185.17	182.24	181.72	155.90
.28 per pound	68.68	119.74	143.68	139.81	138.88	112.60
.26 per pound	32.44	80.11	102.18	97.38	96.04	69.30
.24 per pound	- 3.92	40.48	66.68	54.95	53.20	25.99
.22 per pound	- 40.29	.84	19.19	12.52	10.37	- 17.31
.20 per pound	- 76.66	- 38.79	- 22.31	- 29.91	- 32.47	- 60.62

As expected, given the returns to entrepreneurship previously presented, valuing managerial labor and land at opportunity costs of zero significantly increased returns both on a total and per-acre basis. Farm Situation III had the highest returns to land, management and entrepreneurship on both a total and per-acre-of-land basis, ranging from $1,093.48 and $288.92 at 35 cents per pound to a -$3,636.52 and -$22.31 at 20 cents per pound, respectively. Farm Situation I had the lowest returns to land, management, and entrepreneurship of all situations studied: total returns and returns per acre of land ranged from $-1,965.14 and $196.11 at a 35-cent per pound price to a -$12,494.86 and -$76.66 at a price of 20 cents per pound.

As indicated earlier by returns to entrepreneurship, though Farm Situation III had the highest return to land, management, and entrepreneurship of all Situations, there was no meaningful difference in the returns of Situations III, IV, or V.

CONCLUSIONS

The major conclusion which can be made from this study is that the size of pond does have a significant effect on the costs of production. Over the pond sizes and arrangements studied both economies and diseconomies attributable to pond size were observed. Most of the economies of size appear to have been associated with pond construction costs. Diseconomies, or increases in cost with increases in pond size, observed were attributable to increases in harvest equipment and labor requirements, and disease, pest, and weed control.

Not only does size, but also configuration of the pond significantly affect cost of production. For example, harvesting equipment costs which increased with increases in pond size were closely related to pond shape. In general, the narrower the pond the lower investment requirements and operating costs of harvesting equipment.

That the indivisibility of certain resources assumed for this study is in fact realistic as believed, achievement of the economies observed requires a substantial investment. Over the prices assumed the catfish enterprise could yield either substantial net returns or losses. The individual decision to develop this alternative would not be based on net returns alone but also the amount of investment required and the loan repayment schedule if investment funds were borrowed.

In the absence of definitive research on the demand for catfish for food and unless price-cost relationships change it would appear that more resources will be devoted to the catfish enterprise. Net returns appear to be lucrative enough to attract and retain resources.

Considerable controversy has prevailed over the relative merits of "floating" and "sinking" feed. Since no differences in feed conversion ratio has been identified and floating feed is more costly, it has been suggested that managers may use floating feed as a management tool (a means of avoiding overfeeding and observing the fish). At a prevailing price differential of approximately $30.00 per ton it would appear that floating feed is a costly substitute for some management skills. At the feeding rates employed in this study "floating" feed costs $54.15 more per surface acre than does "sinking" feed. For 142.4 surface acres of water (Farm Situation III) this amounts to $7,710.96 or more than one-half the cost of the manager's salary used in this study.

It is believed that the detailed specification and accounting of costs in this study lend flexibility and adaptability to the data. If changes in some component are appropriate due to, say, technological advances, the necessary changes could be made in that component and cost recalculated with a minimum of effort. Similarly a producer with different costs for certain components should be able to compare his costs with those of the study in efforts to improve his efficiency and return position.

IMPLICATIONS FOR FUTURE RESEARCH

From this study, two areas appear to hold substantial promise for gains in efficiency—feed and fingerlings. Data on the response of catfish of different sizes and ages over a broad range of stocking rates to different kinds and qualities of feed are needed. Other research has established that the carrying capacity of a body of water is dependent mainly on its surface area rather than its depth or volume **(29, pp. 230-231)**. Therefore, studies to supply the response data needs mentioned above should be conducted in ponds of various sizes—including those sizes characteristic of commercial producers. Considering the magnitude of feed and fingerlings as components of total cost and the investment and cost economies of pond construction, it would appear that research funds allocated toward the above data needs would have a high "payoff potential."

If fingerling production by a commercial food fish producer can reduce the effective supply price of his fingerlings, significant cost reductions could be realized. Data are needed not only on alternative fingerling production methods but also on the compatability of fingerling production and food fish production.

For certain pond sizes the mechanical seine hauling technique of harvest allows low per-unit harvesting costs to be achieved. Thus, it would appear that the largest effeciency gains to be made in the general area of harvesting would be associated with solution of the logistical problems of transporting harvest fish and the development of acceptable partial harvesting techniques.

The logistical problems of transporting harvested fish which for this study limited harvest to 20,000 pounds per day are significant and appear to prevent economies that may be possible with the larger ponds. Development of techniques that would reduce or remove this daily harvesting restriction should reduce harvesting costs on ponds having yiel excess of the daily harvesting limit.

The stocking rate and feed conve ratio were assumed as a constant pe face acre for all pond sizes. It has asserted by professional workers that duction could be expected to vary pond size. Should future research stantiate these assertions, the effec cost per pound by pond size could b nificant since feed and fingerlings co tute such a large proportion of costs.

Investigations of the possibilit building and managing ponds to capit on observed economies would appe be very productive—for example, the sibility of building large ponds in ord obtain those economies associated pond construction while providing capability of dividing the pond into s units in order to gain some of the ec mies, such as harvesting, associated smaller pond size. A large pond with merged levees or barriers that woul effect divide a large pond into se smaller ponds when the water lev lowered a foot or so is such a possibi

The manager's salary made a sig cant contribution to total costs. If manager can manage a larger numbe surface acres than studied here, sig cant economies could be achieved. though such a hypothesis seems rea able, it was beyond the scope of study to investigate such a possibility.

Many recommendations on the ca enterprise have been published and ported or interpreted to apply to a ra broad base. Efforts to integrate these ommendations into a coherent pro tion system revealed that in several stances such recommendations were consistent and in fact incompatible. ture recommendations (and existing ommendations) should be scrutinize to compatibility with the general leve technology characterizing the industry

APPENDIX

DERIVATION OF TECHNICAL COEFFICIENTS

echnical coefficients employed in
study are the results of a synthesis of
ommendations of professional re-
chers and published research results.
a new enterprise such as catfish
h is characterized by limited empiri-
data, the technical coefficients ob-
d are not a consensus. Rather they
esent a standard specified from a
e of possibilities in light of their in-
ed usage. It is the purpose of this sec-
to detail the development of these
nical coefficients and to ascertain
consistency when combined to de-
the basic management system.

Basic Management System

he production system analyzed was
ned to produce a marketable food
in one growing season. The period of
h 15 to October 15 (210 days) em-
d in this study was selected on the
nption that on the average by March
ond water will have warmed suffi-
ly that the fish feed regularly and,
ersely, by October 15 water tempera-
will have fallen sufficiently to neces-
discontinuance of regular feeding
To the author's knowledge no data
available on pond water temperature
month from which a more precise de-
tion of growing season could be
ved.

echnical coefficients with respect to
cing rate, size of fingerling stocked,
e conversion rates, mortality rate, and
t production per surface acre are judg-
e estimates based on consultations
t Dr. Wendell J. Lorio.[1/] The perfor-
ce levels should not be taken as gen-
a "recommendations" or "optimums"
but rather they should be interpreted in light of the nature of the study, level of management, and their feasibility when integrated into a total production program.

It was the consensus of opinion that 6-inch fingerlings should be stocked in order to insure production of a marketable food fish in one season. Of course some undersize fish will be present at harvest; however, it is assumed that in consideration of the performance levels and associated requirements the number of undersize fish at harvest would be negligible.

The mortality rate of 5.0 percent of the original stocking rate is a synthesis of estimates obtained from Lorio and Wellborn.[2/] This level of mortality is considered conservative and the resulting survival rate readily attainable in light of the disease and parasite control program assumed for the study. It should be noted that the mortality figure as derived considers the problem of "low count" which evolves from fingerling numbers commonly being estimated on a sample weight basis and thus subject to considerable variation.

Recommendations with respect to stocking rate and feed conversion on gain were given as 2,000 per surface acre and 1.6:1, respectively. While these levels of performance exceed standard recommendations, they are considered readily attainable and commensurate with the total

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[1/] Dr. Wendell J. Lorio is an assistant professor of Wildlife and Fisheries at Mississippi State University.

[2/] Dr. Thomas J. Wellborn, Jr. is the leader of the Wildlife and Fisheries Department of the Mississippi Cooperative Extension Service.

level of management assumed for the study (34).

Published results and recommendations are inconsistent with respect to total production to be expected on a per-surface-acre-of-water or individual-fish basis. This "yield" uncertainty or variations is likely associated with the paucity of published research results concerning the yield response of catfish. The source of data for current recommendations appears to be a growth curve for channel catfish reported by Hastings (19). Hastings' growth curve for channel catfish is for a 1,500-per-surface-acre stocking rate, holding all other factors constant, and allowing time to vary. If in fact any other factor differs—a different stocking rate is applicable, an improved ration is utilized, natural fertility of sites differ, management practices differ, a different or improved strain of channel catfish is used, etc.—inferences and extrapolations based on this curve would not be appropriate. This discussion is not intended to be a criticism of Hastings' research but rather it is an attempt to demonstrate a possible explanation (a major one in the researchers' opinion) for the inconsistency of current recommendations and variations in expected yields—which makes reconciliation of such recommendations into a single coefficient extremely difficult.

In light of the above discussion, development of coefficients for total production per surface acre and per fish are by necessity a synthesis of recommendations which places much weight on judgment and coherence with the basic management system. Using these criteria, a harvested fish is assumed to average 1.25 pounds (live-weight). This weight fish is adjudged to be attainable under the management system considered and is expected to produce a 11.2-ounce dre product (at a dressing percentage o 5 percent).[3/] This is a salable produc by the catfish industry's criterion.

Given the technical coefficients d el oped for stocking rate, mortality te and the weight of a harvested fish ta production of salable food fish per u face acre of water was estimated t b 2,375.0 pounds. [2,000 fingerlin 100.0 fish lost (5.0 percent death lo = 1,900.0 harvestable fish. 1,900.0 fi 1.25 (pounds per fish) = 2,3 pounds.] This level of production is co sidered to be attainable given the lev o management. Thus, the basic mar ge ment system is deemed feasible.

Pond Construction

The pond designs and coefficien c pond construction were developed in co sultation with Soil Conservation Se c personnel.[4/] Assumptions, designs n coefficients are specifically related t hypothetical firms under study; how e it is believed that this system is fea ib and adaptable to real situations.

There are two basic assumptions ab underlie the generation of pond cons tion coefficients. First, the land avai bl for ponds is assumed to be a sq 160-acre tract. The second assump o deals with topography. For the purp se

[3/]The 20-ounce live fish and the resu 11.2-ounce salable product should not be i e preted as "optimums." These are coeffic n employed in this study in order to devel feasible management system producing a a ketable product.

[4/]Agricultural Engineer, Tom E. Blay District Conservationists, Donald C. Temp o and Ike C. Presley; and Soil Conservation T nicians Jacky Ray Taylor and Winfor Turner.

his study the land is assumed to be

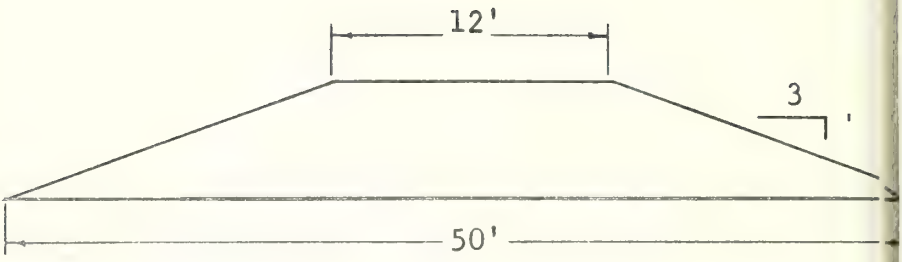
his latter assumption is believed to be
o practical for the purposes of this
a/ for three reasons. First, the area of
e tate toward which this study is pri-
a y directed, the Delta, is character-
e by an undulating topography which
n:rs assumptions of a given slope and
r tion of run meaningless. Second,
personnel report that in actual prac-
:coefficients developed under a "level
d' assumption do not differ signifi-
r y from the actual earth movement
q rements encountered in construc-
p Thirdly, the assumption of level
n or zero slope would allow the study
e readily adapted to individual situa-
n regardless of topography.

ll levees employed in the design are
e same dimensions. Specifications of
evees assume a minimum water depth
ur feet and a maximum water depth
x feet with maintenance of a two-
freeboard. A fall of approximately
2of a foot per 100 feet of run is incor-
ted into the levee coefficients. Simi-
l, clearing of obstructions and leveling
e pond bottom has been taken into
nderation. All levees have minimum
slope of 3 to 1 and a top width of
een feet. (Appendix Figure 1). These
fications form the basis of the levee
struction coefficient. Thus, earth
ng requirements in this study are es-
ted to be 7.11 cubic yards per linear
of run.

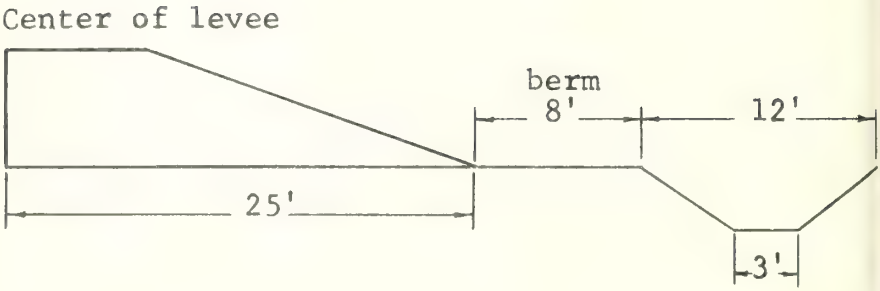
iven the basic levee specifications,
l arrangement and drainage provi-
s must be established prior to deriva-
of levee construction coefficients.
ponds must have access to drainage
tures. For the purposes of this study,
160-acre tract is designed with drain-
ditches on two opposite sides. These structures are of standard SCS design, being three feet wide in the bottom and twelve feet wide across the top. Allowance for an eight foot wide berm between each ditch and paralleling levee was made. Several drainage schemes could be established for a given land area as employed in this study. The one selected for incorporation into this study was chosen for its efficiency in land use and provisions for firm expansion. (See Appendix Figures 2 and 3a-3f).

The arrangement of ponds of the same size to form the six Farm Situations analyzed are in essence successive divisions of each preceding pond size into two equal sized units beginning with the 160-acre unit until the 5-acre unit is reached. The arrangements of ponds shown in Appendix Figure 3a through Figure 3f are obviously not the only arrangements or configurations that could be derived. However, these are considered efficient and are identical to actual Soil Conservation Service plans developed for similar land areas. The earth moving requirements for Farm Situation I through VI are presented in Appendix Table 1.

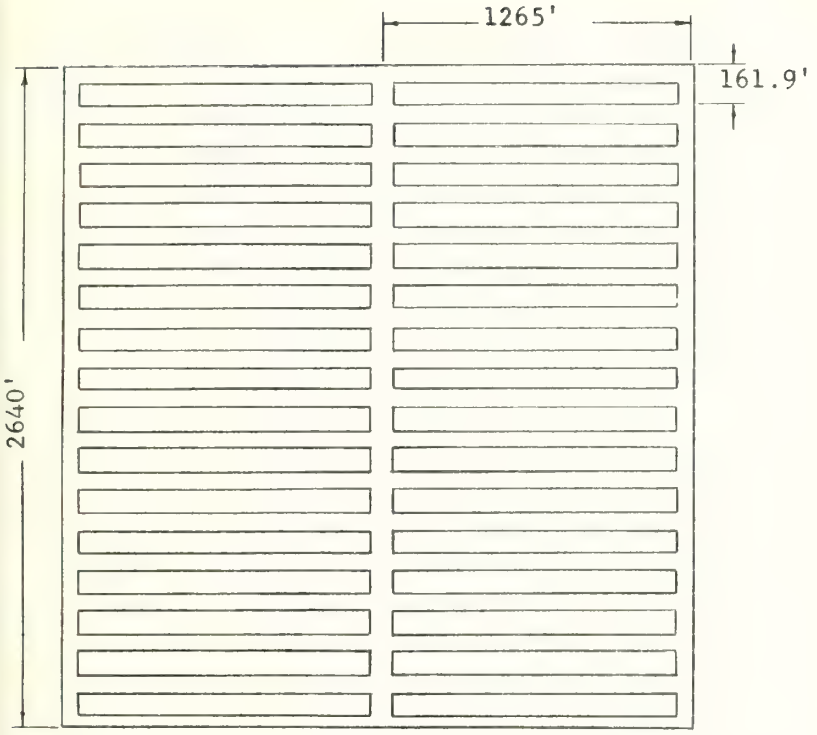
Associated with pond construction is the installation of facilities to drain each pond. The system for drainage incorporated into pond design for this study is commonly referred to as the "gate and screen." For Farm Situations I, II, and III one "gate and screen" and one sixty-five-foot length of twelve-inch pipe for each pond is incorporated into the pond construction coefficients. For Farm Situations IV and V, each pond is drained by one "gate and screen" and one sixty-five-foot length of sixteen-inch pipe. Farm Situation VI's design includes two gates and screens and two sixty-five-foot lengths of sixteen-inch pipe. It is assumed that these facilities are sufficient to meet



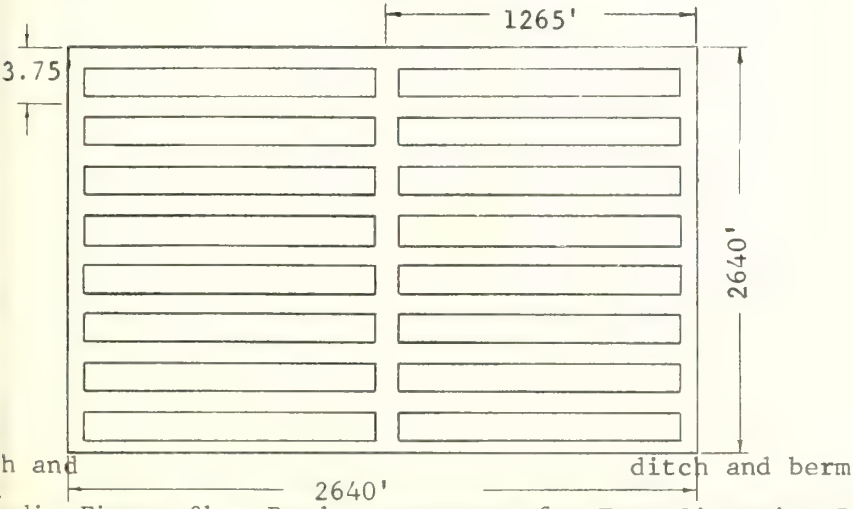
Appendix Figure 1. Levee specifications



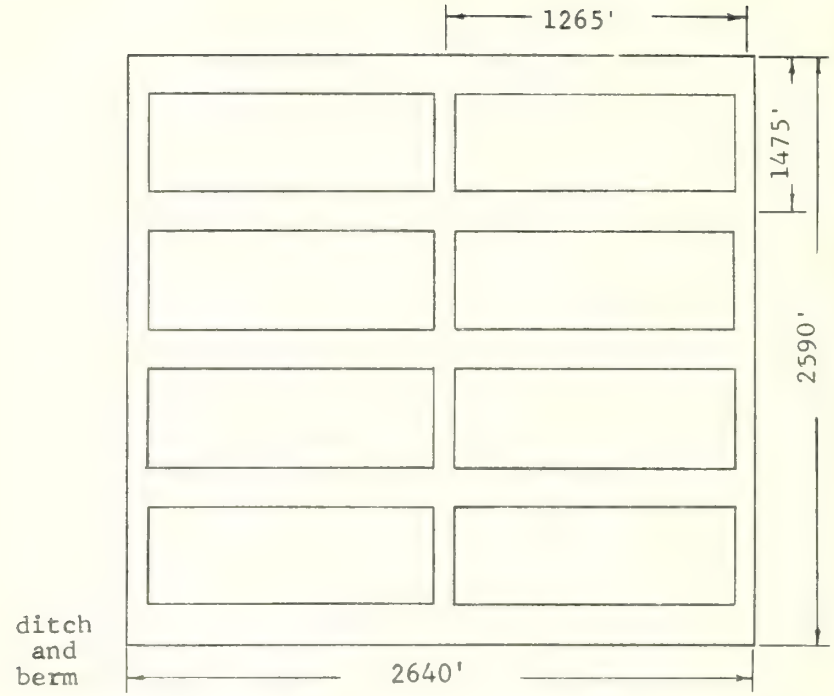
Appendix Figure 2. Diagram of drainage ditch-levee relationship.



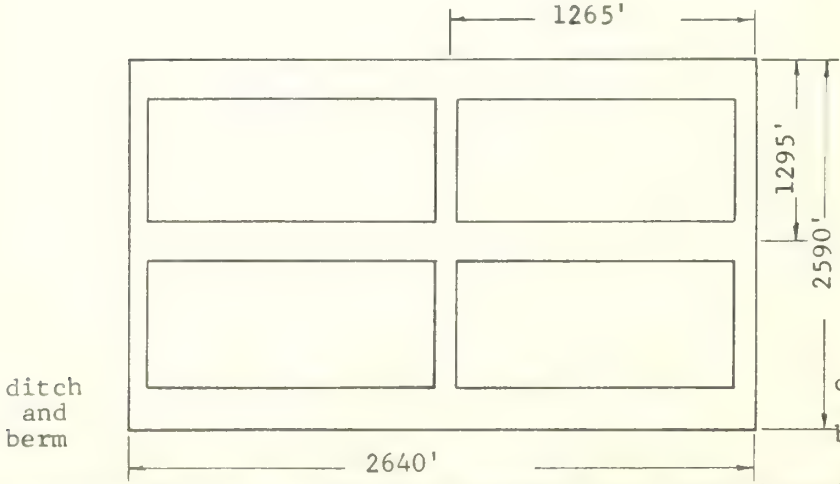
Appendix Figure 3a. Pond arrangement for Farm Situation I.



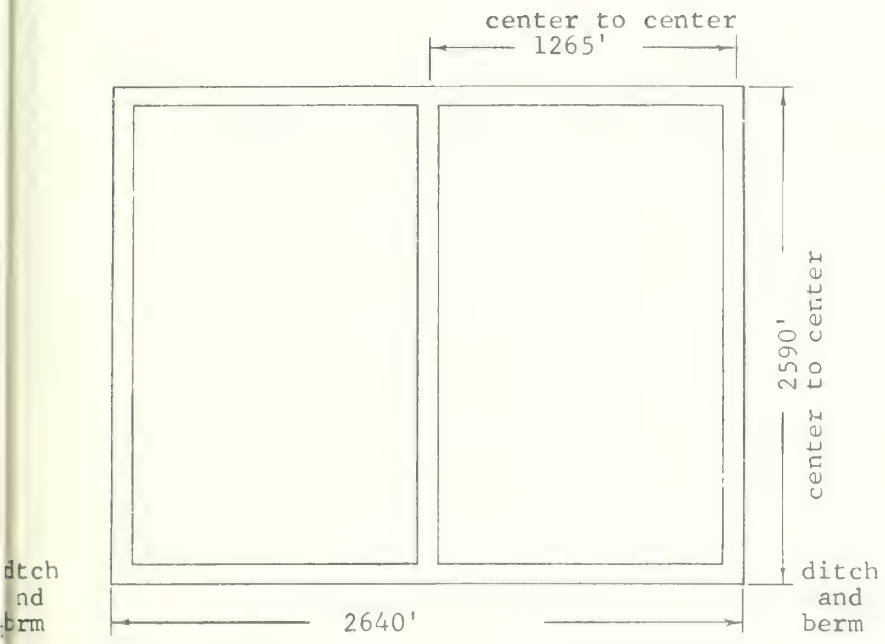
ppendix Figure 3b. Pond arrangement for Farm Situation II.



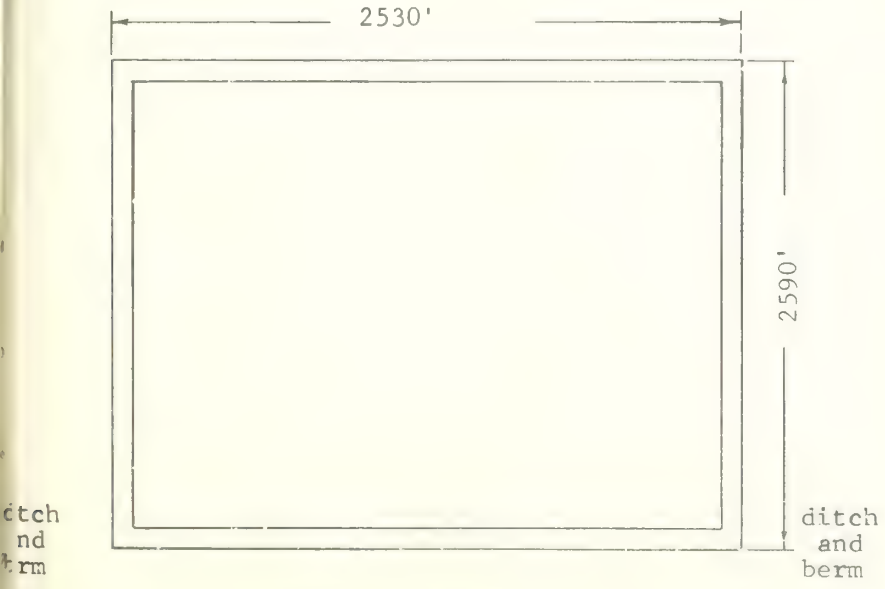
Appendix Figure 3c. Pond arrangement for Farm Situation III.



Appendix Figure 3d. Pond arrangement for Farm Situation I



Appendix Figure 3d. Pond arrangement for Farm Situation V.



Appendix Figure 3f. Pond arrangement for Farm Situation VI.

Appendix Table 1. Estimated linear feet of levee run and total volume of ar moved by Farm Situation.

Farm Situation	Linear feet of levee	Cubic yards per foot of run	Total vol e of earth mo d
	linear feet	cubic yards	cubic ya s
I	50,604	7.11	359,794.
II	30,428	7.11	216,343.
III	20,342	7.11	144,631.
IV	15,290	7.11	108,711.
V	12,776	7.11	90,766.
VI	10,200	7.11	72,522.

the water replacement requirements associated with oxygen depletion problems.

All-weather access to the pond is required by the management program employed. To insure all-weather access, four inches of standard road gravel were applied to levees in an eight-foot width. On these specifications, one cubic yard of gravel will surface ten linear feet of levee run. For Farm Situations I, II, and III all-weather access is defined as each pon being bordered on a minimum of tw sides by graveled levees. In Situation IV V, and VI, all-weather access requires tha all levees have graveled crowns. Tes gravel accesses are assumed to hav five-year life. Coefficients with respe to all-weather surfacing are presented in Ap pendix Table 2.

Appendix Table 2. Estimated linear feet of levee run requiring all-weather surfacing and total cubic yards of gravel used by Farm Situation.

Farm Situation	Linear feet of levee run	Total volume of gravel
	linear feet	cubic yards
I	30,690.0	3,069.0
II	20,570.0	2,057.0
III	15,510.0	1,551.0
IV	15,510.0	1,551.0
V	12,980.0	1,298.0
VI	10,340.0	1,034.0

Pond levees are subject to erosion and refore should be properly seeded to etative cover and annually maintained , **pp. 32-33).** Conventional estimates pond maintenance are given as a per- t of initial pond construction costs per e of land per year. The customary per- tage used is .25. The implication made such usage is that the requirement for ablishment and maintenance of levees s not vary with pond size or farm size. wever, the amount of levee surface ex- ed varies significantly as pond and n size vary. In a study of economies ociated with pond size, these differ- es should be considered. To this re- rcher's knowledge there are no data ilable on pond maintenance to gener- the necessary coefficients. However, n effort to reflect these differences in ablishment and maintenance of levees associated with ponds of various sizes constructed from a given tract of land, a scheme was developed for use in this study. Exposed surface area requiring vegetative cover establishment and maintenance was calculated as to acreage for all Farm Situations. This acreage was then treated as fescue pasture and an annual charge for establishing and maintaining fescue pasture sod was adopted from a recent forage evaluation study **(26).** It is recognized that this is not a complete solution to the question of pond maintenance per se but it is believed that this scheme provides a logical and a technically appropriate approach from a vegetative cover standpoint while recognizing variations in pond size.

The acreages per Farm Situation subject to annual maintenance and establishment charges are summarized as follows:

Farm situation	Acres of land
I	16.9
II	12.28
III	9.9
IV	8.79
V	8.21
VI	7.60

ter Supply

Wells were selected as the source of ter since, in general, well water is free undesirable fish, dependable during longed drought, and generally free of asites, diseases, industrial pollutants, l pesticide residues **(13, pp. 20-21, and p. 68).**

In 1970 Meyer, **et al. (25, p. 2)** reported that earlier recommendations of a 13 g.p.m. per acre minimum water delivery capability for planning purposes were proving inadequate and that a 50 g.p.m. figure may be more ideal. At present some research personnel and "better" producers are in the process of examining

this latter recommendation and the consensus of opinion prevailing is that 50 g.p.m. is possibly a bare minimum and that the recommendation for minimum water delivery capability should probably be raised to 100-150 g.p.m. per acre. In view of the absence of definitive research on the matter and in consideration of the management restraints, 100 g.p.m. minimum flow was used in this study.

Wells and associated pumping units can be obtained with various rated pumping capacities. Selection of the 2,000 and 3,000 g.p.m. rated capacities for use in the study was therefore somewhat arbitrary. However, these sizes are the most common sizes currently in use in the Delta of Mississippi and are the most common sizes recommended by professional drilling services of the region. The estimated cost of these size wells and associated pumping units is presented in Appendix Tables 17 and 18.

In general there are four pumping unit fuel sources available: butane, diesel, electricity, and gasoline. In any given situation, either of these sources may be a least-cost choice. To this researcher's knowledge there are no published studies available and/or applicable to the general study area that provides an economic analysis of pumping unit fuel alternatives. Thus, selection of a fuel was somewhat arbitrary with certain qualifications.

The fuel of choice for this study was diesel. Professional irrigation and well drilling specialists indicated that most farmers of the area typically consider only the diesel and electrical power alternatives. The choice between electricity and diesel is then a matter of personal preference coupled with the availability of three-phase electrical current. Three-phase current is not presently available in all areas of catfish production. A [illegible] going study of rice farms [5/] revealed [illegible] power sources of newly installed and [illegible] ovated wells tends to parallel that [illegible] for farm power in the area and dies [illegible] pears to have become the fuel of c[illegible] for farm power.

Diesel fuel consumption rates fo[illegible] 2,000 and 3,000 g.p.m. wells were [illegible] mated to be 2.88 and 5.18 gallon p[illegible] hour of pumping time, respect[illegible] These fuel consumption rates were d[illegible] oped in consultation with Dr. C. D[illegible] Veal.[6/] Standard procedures were [illegible] ployed to convert acre-feet required m[illegible] into hours of pumping time. [illegible] pumping time and gallons of diesel u[illegible] required by Farm Situation are prese[illegible] in Appendix Table 3.

The total quantity of water utiliz[illegible] one production period is some fun[illegible] of pond depth, evaporation, rainfall, s[illegible] age if any, and the water manage[illegible] program employed. Of these, the p[illegible] quantity determinants are pond d[illegible] and the water management program.

Initial requirements for filling p[illegible] to an average depth of 5 feet were c[illegible] lated by standard engineering proced[illegible] Data[7/] on pan evaporation by mont[illegible] production period was converted to [illegible] surface evaporation data at the acce[illegible]

5/Reference is to research being cond[illegible] under Supplement No. 2 FPE, Agreemen[illegible] 12-17-01-7-283 by James G. Hamill, Miss[illegible] Agricultural and Forestry Experiment St[illegible] and Fred T. Cooke, FPED, USDA.

6/Dr. C. David Veal is an Assistant Pro[illegible] of Agricultural and Biological Engineer[illegible] Mississippi State University.

7/The recording station for these data[illegible] cated at Scott, Mississippi. It is considere[illegible] resentative of the Delta.

ndix Table 3. Estimated total hours pumping time and diesel fuel in gallons required for water supply and management by well size for Farm Situations I-VI.

ation	Hours of pumping time		Fuel consumption	
	2,000 well (g.p.m.)	3,000 well	2,000 well (g.p.m.)	3,000 well
	-------hours---------		--------gallons---------	
	703.94	3,285.12	2,027.36	17,016.92
	767.10	3,579.55	2,209.25	18,592.08
		4,283.60		22,189.05
		4,379.87		22,687.72
		4,421.98		22,905.86
		4,470.11		23,155.17

of .70 and correlated with mean nthly precipitation data. In those nths that evaporation exceeded precipon, the difference was utilized in demining total water requirements (23, p. 2). The water management proam followed is assumed to be adequate the months of March and April. nty percent of the initial volume is aced during May and twenty-five per of the initial volume is replaced in . July, August, and September are rally considered the critical water agement months in Mississippi pond are. In each of these months fifty percent of the initial volume is replaced. In October, the month of harvest, 20 percent of the initial volume is replaced. Obviously such a water management program is somewhat arbitrary as neither published research data nor recommendations are available from which a more definite water management program could be adapted. It is believed that this program is compatible with the level of management assumed for the study.

Initial filling and monthly quantities of water per surface acre as developed by the previously discussed procedures are presented below:

Item or month	Water in acre feet
Initial filling	5.0
March	--
April	--
May	1.07
June	1.46
July	2.68
August	2.74
September	2.62
October	1.04
Total	16.61

Feeding

Controversy over the relative mertis of feeding the extruded pellets (sinking feed) versus the feeding of expanded pellets (floating feed) has persisted for some time. Davis and Hughes report:

> . . . Many indirect benefits have been ascribed to feeding floating pellets. Major values claimed include: better food conversion, better regulation of amounts of feed, and better disease and parasite control because you can see the fish feed. The most important deterent is the $30-50.00 per ton added cost.
>
> Under controlled conditions we have been unable to demonstrate any better feed conversion from either floating or sinking pellets. In addition, experienced growers are able to regulate feed very accurately using sinking feed. Fish going off feed is the best indication of disease, parasites or low oxygen. Again experienced growers ascertain this equally well from either sinking or floating feed. **(7, p. 26).**

Thus it appears that the feed of choice is closely related to the skill and experience of the manager. Other published materials on the subject have alluded that skill and experience of the manager is the most important consideration in selecting the type of feed to use **(16, p. 11** and **34, pp. 35-37).** Given the high level of managerial ability assumed in this study and the cost-relationships[8/] of the two forms, the extruded pellet[9/] was selected as the feed of choice.

Conventional recommendations c feeding rate of catfish for food are g 3-5 percent of body weight on a si per week or a daily basis. Guidelin deviation from these recommenda under varying climate and stress c tions are available **(16, pp. 11-13 a pp. 27-29).** Given the conditio feeding schedule can be stimulated. ever, conceding to the 1.6:1 feed co sion ratio; initial fingerling weight, the harvested fish weight of the management system assumed for study, simulation of a feeding sch would be redundant. Performance of equipment indicate that in no p of the production process will sched labor requirements exceed the labor ply indigenous to the firm(s) on a basis.

The feeding operation is accompli with the use of a commercially prod p.t.o. driven fish feeder. It has a ho capacity of 1,500 pounds with a brated discharge. Feeder specificatio dicate that one feeder is sufficiently with sufficient flexibility in perform rates to exceed the maximum feeding rates required for all Farm S tions analyzed. A bulk feed handlin cility with a 12.0 ton capacity is inclu in the design. One of these units is co ered sufficient storage capacity since maximum daily feeding rate of 30.0

8/Assuming feed costs of $90.00 per to "sinking" feed, $120.00 per ton for "float feed, and a 1.6:1 feed conversion on "sink feed, **ceteris paribus,** a feed conversion rat 1.2:1 would be required from "floating" to achieve the same feed cost per pound of obtained with "sinking" feed ($.072).

9/The extruded pellet should meet the tritional and processing specifications descr in **Report to the Fish Farmers** (3 pp. 35-37)

surface acre this size unit would hold k-day supply of feed. The estimated of owning and operating the equipt complement is presented in Appen-Table 15.

ase, Parasite, and Weed Control

Given the infant nature of the catfish ning industry, the quantification of in- coefficients associated with disease, site and weed control necessitates judgment decisions be made with re- t to the probability of occurrence of ific types of infections and/or infesta- s as well as prescription of prevention tment. Accordingly, for the purposes this study, a disease, parasite, and d treatment and prevention schedule developed in consultation with Dr. mas J. Wellborn, Jr. (See Appendix le 4). It should be noted that this dule is based on and is an integral of the total management "package" loyed in the study, and is purported pproach those problems a manager reasonably expect under the environtal conditions of Mississippi. Also, in rticular situation these problems may occur or only a few of these problems occur in which case the associated s would not be incurred. However, nd management plans must allow for a program.

s a component of the total manage- t program, certain practices and pment are included in estimated costs eflect the level of management. These ude a minimum of one oxygen deter- ation check per pod per day during ods of stress, the equipment for such , and the equipment necessary to ap- recommended treatments (See Apdix Tables 22-23). Coupled with these siderations is the assumption that the manager possess certain biological skills and is capable of recognizing stress conditions and some early symptoms.

At present very few chemicals and herbicides useful in fish culture have been approved by the Food and Drug Administration for use on food fish. The chemicals employed in this study are those found to be effective and most commonly used. **Inclusion of chemicals not approved by the F.D.A. in the control program should not be misconstrued to imply recommendation by the authors or the Mississippi Agricultural and Forestry Experiment Station.**

The estimated chemical requirements by Farm Situation are presented in Appendix Table 5.

Harvesting[10/]

The mechanized seining technique was employed in this study. This selection was based on the technique flexibility with respect to time and extent of harvest, and a capability to harvest ponds of at least 160 acres **(2, p. 64).** This harvesting technique operates most efficiently under certain specified conditions. In order to insure compatibility of mechanized seining and the production plant these conditions must be satisifed. The most important of these are: (1) consistent slope and eveness of the pond bottom; (2) absence of irregular shapes; and (3) all-weather access to all ponds on at least three sides. These have been discussed in a previous section. Fulfillment

[10/]The coefficients developed for this technical unit were developed in consultation with Mr. Donald C. Greenland and Mr. Robert L. Gill of the National Marine Fisheries Services Research Station, Rowher, Arkansas.

Appendix Table 4. Basic disease, parasite, and weed control program developed for the study.

ITEM	Frequency of occurrence	Ponds requiring treatment	Possible treatment
		-Percent-	
Fingerling treatment	Annually at stocking	100.0	250 p.p.m. formalin for one hour
Parasite incidence	Once annually	10.0	2 p.p.m. of potassium permanganate
Bacterial incidence	Once annually	10.0	2.5 grams of active Terramycin per 100 lbs. body weight per day for 10 days (in feed)
Weed control	Once annually	50.0	one-half of acreage with copper sulfate at 1 p.p.m. and one-half of acreage with Karmex at .5 lb. per surface acre.

Source: Developed in consultation with Dr. Thomas L. Wellborn, Jr.

Appendix Table 5. Estimated total requirements of selected chemicals for disease, parasite, and weed control by Farm Situation, Mississippi, 1971.

ITEM	Farm Situation					
Formalin for fingerling treatment[1/]	1.95 gal.	2.12 gal.	2.22 gal.	2.27 gal.	2.30 gal.	2.32 gal.
Potassium permanganate for parasite incidence[2/]	421.2 lb.	459.0 lb.	480.6 lb.	982.8 lb.	1984.5 lb.	4012.2 lb.
Terramycin for bacterial incidence[3/]	16.31 lb.	17.78 lb.	18.62 lb.	38.07 lb.	76.88 lb.	155.44 lb.
Weed control[4/]						
Copper sulfate	421.2 lb.	459.0 lb.	480.6 lb.	491.4 lb.	992.3 lb.	2006.1 lb.
Karmex	15.6 lb.	17.0 lb.	17.8 lb.	18.2 lb.	36.75 lb.	74.25 lb.

[1/] 2,000 fingerlings per 62.5 gal. of water @ .95 grams per gallon.

[2/] 2 p.p.m. = 5.4 pounds per acre foot.

[3/] 2.5 grams active material per day per 100 lbs. of body weight for 10 days assuming fish average .8 lb. each. (1,046 lb. active material per surface acre).

[4/] One-half of acreage with copper sulfate and one-half with Karmex.

Source: Based on Appendix Table 4.

of these requirements renders mechanized seining as a feasible harvesting technique for the Farm Situations analyzed in this study.

Coefficients were developed for each of the six Farm Situations analyzed. The performance rates and equipment complement were based on the system as employed by the demonstration harvesting crew of the National Marine Fisheries Service Experiment Station[11/] (Appendix Table 6). It is recognized that this demonstration crew has attained a level of proficiency which would be difficult to achieve under typical farm situations staffed with locally available part-time help. To account for such differences, the full-time labor complement (a manager and one laborer) assumed for the study is assumed to assist in the harvesting operation. However, it is believed that a custom harvesting crew could achieve the same level of proficiency as obtained by the National Marine Fisheries Service demonstration team. Thus, to render as much flexibiilty to the data as possible the labor coefficients as developed by pond size are presented exclusive of the study's assumed labor complement. The labor requirements by pond size are presented in Appendix Tables 7-12.

Given the procedural labor restraints, three additional conditions are extremely important in the determination of total labor requirements for harvesting a pond of a given size. First, and most limiting, is the assumption with respect to the total amount of fish that may be disposed of in one day. This quantity is directly related to capacity of live haul trucks, holding capacity of the receiving facility, and season of the year. In consideration of the conditions currently existing in the field and the winter harvesting, it was assumed that a maximum of 20,000 pounds of fish could be shipped from the firm in a day. Secondly, as previously mentioned the study assumes that harvesting is performed in the cooler months (October through February). At temperatures higher than those which normally prevail in this period the quantities of fish that can be retained in a seine or live haul and hauled in live haul facilities are significantly reduced. Thirdly, the mechanized seine hauling technique does not capture all fish in one sweep of the pond. With properly constructed ponds and strict application of harvesting procedures as developed, it is possible to catch 90 percent of the total quantity of fish present in the pond on the first seine haul. The remaining quantity of fish can then be removed by subsequent seine hauling, draining and capture, and possibly poisoning and removal. In view of the quantities of fish involved in this study and the lack of data on this subject, it is assumed that the total quantity of fish left after the first haul is captured by the second haul. If in fact some fish should remain this should present no serious problem as ponds would eventually be drained for repairs or water management and predation on subsequently stocked fingerlings is limited **(2, p. 64)**. The data as presented on harvesting must be interpreted in light of these three assumptions.

Harvesting cost by Farm Situation is presented in Appendix Tables 25 through 30.

Miscellanea

The six Farm Situations analyzed in this study were assumed to require

11/For a narrative discussion of the actual harvesting procedure and a description of the required equipment the reader is referred to Coon, **et al. op. cit.**, Bossu, **op. cit.**, and Grizzle, **op. cit.**

Appendix Table 6. Basic data by operation utilized in the estimation of labor requirements for harvesting selected

OPERATION	Production Unit Size											
	5 acres		10 acres		20 acres		40 acres		80 acres		160 acres	
	Hrs.	No. in crew	Hrs.	No. in crew	Hrs.	No. in crew	Hrs.	No. in crew	Hrs.	No. in crew	Hrs.	No. in crew
Rig & Set up Equipment for Seine Hauling												
Preliminary equipment check	1.0	1	1.0	1	1.0	1	1.0	1	1.0	1	1.0	1
Rig seine (per 200 ft.)	.25	3	.25	3	.25	3	.25	4	.25	4	.25	6
Lower into pond & position line hauler	.33	3	.33	3	.33	3	.33	4	.33	4	.33	6
Run haul lines (per 100 ft.)	.04	3	.04	3	.04	3	.04	4	.04	4	.04	6
Hauling, Trapping, & Maintenance of Trapped Fish												
Hauling the seine (per 25 ft.)[1/]	.017	3	.017	3	.017	3	.017	4	.017	4	.017	6
Remove live car and/ or secure seine	.33	3	.33	3	.33	3	.33	4	.33	4	.33	6
Loading the Fish												
From live car per 1000 lbs.	.2	3	.2	3	.2	3						
From haul seing per 1000 lbs.							.5	4	.5	4	.5	4
Cleanup, Gear Maintenance and Storage per 100 ft. of seine	.2	2	.2	2	.2	2	.2	2	.2	2	.2	2

[1/] Seine hauled at rate of 25 feet per minute.

Source: Developed from data supplied by Donald C. Greenland and Robert L. Gill of the National Marine Fisheries Research Station, Rowher, Arkansas.

Appendix Table 7. Catfish harvest: Estimated labor requirement by operation for a 5-acre pond, Mississippi, 1971.[1/]

OPERATION	Time requirement per operation	Number of workers in crew	Total man hours per operation
	----hours----		---hours---
1. Preliminary equipment check	1.00	1	1.00
2. Rig seine (200 ft.)	.25	3	.75
3. Lower seine into pond and position line hauler	.33	3	.99
4. Run haul lines (2780 ft.) and set seine	1.14	3	3.30
5. Haul seine (1250 ft.)	.85	3	2.55
6. Remove and secure live car	.33	3	.99
7. Loading fish (8336.0 lbs.)[2/]	1.67	3	5.01
8. Second seine haul (sum of items 2 thru 6 above)	2.86	3	8.58
9. Load second haul (926.5 lbs.)[2/]	.20	3	.60
10. Cleanup, gear maintenance, and storage (200 ft. of seine)	.40	2	.80
TOTAL	9.03	--	24.57

[1/] Does not include the manager and one full-time employee who are assumed to assist with the harvesting operation.

[2/] Assumes ninety percent catch on first seine haul and remainder on second haul.

See Appendix Table 6 for detailed information on requirements per operation.

ndix Table 8. Catfish harvest: Estimated labor requirement by operation for a 10-acre pond, Mississippi, 1971.[1/]

ATION	Time requirement per operation	Number of workers in crew	Total man hours per operation
	---hours---		--hours--
. Preliminary equipment check	1.00	1	1.00
. Rig seine (450 ft.)	.56	3	1.69
. Lower into pond and line hauler	.33	3	.99
. Run haul line (3250 ft.) and set seine	1.30	3	3.90
. Haul seine (1250 ft.)	.85	3	2.55
. Remove and secure live car	.33	3	.99
. Loading fish (18,168.8 lbs.)[2/]	3.63	3	10.89
. Second seine haul (sum of items 2 thru 6 above)	3.37	3	10.11
. Load second haul (2,018.7 lbs.)[2/]	.40	3	1.20
. Cleanup, gear maintenance, and storage (450 ft. of seine)	.90	2	1.80
TOTAL	12.67	--	35.12

es not include the manager and one full-time employee who are assumed assist with the harvesting operation.

ssume ninety percent catch on first seine haul and remainder on second aul.

e Appendix Table 6 for detailed information on requirement per operation.

Appendix Table 9. Catfish harvest: Estimated labor requirements by oper for a 20-acre pond, Mississippi, 1971.[1/]

OPERATION	Time requirement per operation --hours--	Number of workers in crew	Total m hours p operati --hours
1. Preliminary equipment check	1.00	1	1.00
2. Rig seine (1,000 ft.)	1.25	3	3.75
3. Lower seine into pond & position truck	.33	3	.99
4. Run haul lines & set seine (4,120 ft.)	1.72	3	5.16
5. Hauling seine (1,250 ft.)	.85	3	2.55
6. Remove & secure live car (2 cars)	.66	3	1.97
7. Loading fish (38,047.5 lbs.)[2/]	7.61	3	22.83
8. Maintenance of fish overnight (1 night)[3/]	8.00	1	8.00
9. Second seine haul (sum of items 2 thru 5 above)	4.15	3	12.45
10. Secure live car	.33	3	.99
11. Load second haul (4,227.5 lbs.)[2/]	.86	3	2.58
12. Cleanup, gear maintenance, and storage	2.00	2	4.00
TOTAL	28.76	--	66.27

[1/] Does not include the manager and one full-time employee who are assumed o assist with the harvesting operation.

[2/] Assume ninety percent catch on first seine haul and remainder on second a

[3/] Maximum daily load out of 20,000 lb.

See Appendix Table 6 for detailed information on requirement per operatio

Appendix Table 10. Catfish harvest: Estimated labor requirements by operation for a 40-acre pond, Mississippi, 1971.[1/]

OPERATION	Time requirement per operation	Number of workers in crew	Total man hours per operation
	--hours--		--hours--
. Preliminary equipment check	1.00	1	1.00
2. Rig seine (2,000 ft.)	2.50	4	10.00
3. Lower seine into & position line hauler	.33	4	1.32
4. Run haul line (3,790 ft.)	1.58	4	6.32
5. Haul seine (1,200 ft.)[2/]	.80	4	3.20
6. Secure seine on initial stop	.33	4	1.32
7. Loading fish (77,808.0 lbs.)[3/]	38.90	4	155.60
8. Maintenance of fish overnight (4 nights)[4/]	32.00	1	32.00
9. Second seine haul (sum of items 2 thru 6 above)	5.54	4	22.16
10. Load second haul (8,645.0 lbs.)[3/]	4.33	4	17.32
11. Cleanup, gear maintenance and storage (2,000 ft. of seine)	4.00	2	8.00
TOTAL	91.31	--	258.24

1/ Does not include the manager and one full-time employee who are assumed to assist with the harvesting operation.

2/ Haul stopped when approximately 1/20 of surface area is enclosed.

3/ Assumes ninety percent catch on first seine haul and remainder on second haul.

4/ Maximum daily load out of 20,000 pounds.

See Appendix Table 6 for detailed information on requirements per operation.

Appendix Table 11. Catfish harvest: Estimated labor requirement by operation for an 80-acre pond, Mississippi, 1971.[1/]

OPERATION	Time requirement per operation --hours--	Number of workers in crew	Total m hours p operati --hours-
1. Preliminary equipment check	1.00	1	1.00
2. Rig seine (2,000 ft.)	2.50	4	10.00
3. Lower seine into pond and position	.33	4	1.32
4. Run haul lines (6,378 ft.)	2.66	4	10.64
5. Haul seine (2,450 ft.)[2/]	1.63	4	6.52
6. Secure seine on initial stop	.33	4	1.32
7. Loading fish (157,106.3 lbs.)[3/]	78.55	4	314.21
8. Maintenance of fish overnight (8 nights)[4/]	64.00	1	64.00
9. Second seine haul (sum of items 2 thru 6 above)	7.45	4	29.80
10. Load second haul (17,456.2 lbs.) [3/]	8.73	4	34.92
11. Maintenance of fish overnight (1 night)[4/]	8.00	1	8.00
12. Cleanup, gear maintenance, and storage (2,000 ft. seine)	4.00	2	8.00
TOTAL	179.18	--	489.73

[1/] Does not include the manager and one full-time employee who are assumed to assist with the harvesting operation.

[2/] Haul stopped when approximately 1/20 of surface area is enclosed.

[3/] Assumes ninety percent catch on first seine haul and the remainder on the second seine haul.

[4/] Maximum daily load out of 20,000 pounds.

See Appendix Table 6 for detailed information on requirement per operation.

ndix Table 12. Catfish harvest: Estimated labor requirement by operation for a 160-acre pond, Mississippi, 1971.[1/]

RATION	Time requirement per operation	Number of workers in crew	Total man hours per operation
	--hours--		--hours--
. Preliminary equipment check	1.00	1	1.00
. Rig seine (3,800 ft.)	4.75	6	28.50
. Lower seine into pond and position truck	.33	6	1.98
. Run haul lines and set seine (7,612 ft.)	3.17	6	19.03
. Haul seine (2,400 ft.)[2/]	1.60	6	9.60
. Secure seine on initial stop	.33	6	1.98
. Loading fish (317,633.0 lbs.)[3/]	158.82	6	952.90
. Maintenance of fish overnight (17 nights)[4/]	136.00	1	136.00
. Second seine haul (sum of items 2 thru 6 above)	10.18	6	61.08
. Load second haul (35,292.0 lbs.) [3/]	17.65	6	105.88
. Maintenance of fish overnight (2 nights)[4/]	16.00	1	16.00
. Cleanup, gear maintenance and storage (3,800 ft. of seine)	7.60	2	13.20
TOTAL	357.43	--	1,347.15

es not include the manager and one full-time employee who are assumed to sist with the harvesting operation.

ul stopped when approximately 1/20 of surface area is enclosed.

sumes ninety percent catch on first seine haul and remainder on second ine haul.

ximum daily load out of 20,000 pounds.

Appendix Table 6 for detailed information on requirements per operation.

tractor of 35-49 h.p. power range for feeding, mowing, and harvesting. The services of a pick-up truck were assumed necessary for conduct of normal management and light hauling. Heavier hauling and harvesting operations necessitate the inclusion of a larger ton-and-a-half vehicle. The costs of owning and operating this equipment were adapted from a recent study by Donald L. Browning **(4)**. The costs, as adapted, are presented in Appendix Tables 14-15.

Normal operations of the six Farm Situations analyzed were assumed to require a storage and service facility. Design and cost of the facility employed in this study was adapted from a recent study of catfish farms in Southeast Arkansas by Garner **(13, p. 22)**. The wood and sheet metal facility is eighteen feet wide, forty-two feet long and contains two concrete holding vats. The costs of this facility are presented in Appendix Table 15.

In addition to 160 acres from which the production units were obtained some quantity of land was required for an cess road, for parking, equipment sotr the service building, and bulk feed fa ties. It was assumed for the purpose this study that 3 acres afforded suffic space.

The tax rate varies among countie the state. Identification of a typical rate for the hypothetical firms of study would be difficult. However, tc flect this cost component all Farm Si tions studied were assessed taxes basec the average rate per acre of taxes le on farm real estate in Mississippi for 1 as reported in **Farm Real Estate Ta (32)**.

Consideration must be given to in ance, bookkeeping and accounting, general office overhead. Costs for t items were adapted from studies Garner **(13)** and Mitchell and Usry (

The estimated annual costs of ta bookkeeping and accounting and in ances are presented in Appendix T 31.

Appendix Table 13. Prices used for catfish production items, Mississippi, 1971.

Item	Unit	Price
		dolla
Fingerlings (6")	each	.0
Feed	ton	90.0
Gravel	cubic yard	4.0
Pipe-		
Water supply	linear foot installed	3.0
Drainage	linear foot installed	3.2
Chemicals:		
Formalin	gallon	1.7
Copper sulfate	pound	.3
Terramycin	pound active ingredient	17.0
Karmex	pound	2.9
Potassium permanganate		
600 lb. drum	each	249.9
110 lb. drum	each	65.0
Hired labor (part-time)	hour	1.6
Diesel	gallon	.2
Earth moving	cubic yard	.2
Vegetative Cover:		
Establishment cost	acre	37.8
Annual maintenance cost	acre	23.4

Appendix Table 14 Basic data used for estimating selected fixed costs for fish farms, West [illegible], 1967 1/

ITEM	Size or description	Estimated new cost	Repairs 2/	Estimated life 2/	Average investments
		-dollars-	as a percent of new cost	years	-dollars-
Seine storage reel	2000' capacity	450.00	50.0	10.0	225.00
Boat and motor	16'boat with 10 h.p. motor	750.00	75.0	10.0	375.00
Boat trailer	Std. commercial	200.00	40.0	10.0	100.00
Line hauler	p.t.o. driven	750.00	50.0	10.0	375.00
Snatch block	--	20.00	20.0	10.0	10.00
Crane	25' reach; 450 lb. capacity	3,500.00	100.0	10.0	1,750.00
Seine supports	"one arm man"	4.00	--	5.0	2.00
Seine platform and motor	7' x 20' x 18' with 20 h.p. motor	1,400.00	75.0	10.0	700.00
Platform trailer	custom	750.00	40.0	10.0	375.00
Feeder 3/	1,500 lb. capacity	1,300.00	75.0	10.0	650.00
Feed storage 3/	Bulk--12.0 ton cap.	650.00	50.0	10.0	325.00
Service buildings 3/	18' x 42'	1,500.00	10.0	20.0	750.00
Relift pump	p.t.o. driven 8" high-lift with aeration attachment	1,855.00	50.0	10.0	927.50
Tractor 4/	35-46 h.p.	5,575.00	150.0	12.0	2,787.50
Mowing machine	7'	546.00	125.0	12.0	273.00
			dollars per unit		
Haul seine with funnel and hoop	200'section of 10' seine with 1" mesh	360.00	20.00 per section	5.0	180.00
Haul seine	200' section of 10' seine with 1" mesh	350.00	20.00	5.0	175.00
			dollars per unit		
Cutting seine	50' section of 6' seine with ½" mesh	80.00	4.00 per section	5.0	40.00
Live car	30,000 lb. cap.	185.00	12.00 per car	5.0	92.50
Live car	10,000 lb. cap.	131.00	9.00 per car	5.0	65.50

Continued

Appendix Table 14. Basic data used for estimating selected equipment and facility costs, Mississippi, 1971.[1/] (Continued)

ITEM	Size or description	Estimated new cost	Repairs[2/]	Estimated life[2/]	Average investments
		-dollars-	dollars per unit	years	--dollars--
Brailing basket	450 lb. capacity	65.00	3.00 per unit	5.0	32.50
Hauling line	600' spool of 3/4" rope	81.00	--	5.0	40.50
Truck[4/]	1 ½ ton	5,000.00	500.00 per year	8.0	2,500.00
Truck[4/]	½ ton	2,750.00	160.00 per year	10.0	1,375.00

1/With exceptions as noted, these estimates were developed by procedures as discussed in the text.

2/Based on manufacturers' specifications and recommendations supplemented with growers and research workers observations.

3/Adopted for use from Garner, Carroll R., "Estimated Investment Requirements Costs and Returns for Five Sizes of Catfish Farms in Southeastern Arkansas," Unpublished M.S. Thesis, University of Arkansas, 1971.

4/Adopted for use from Browning, Donald L., "Economic Evaluation of Major Farm Enterprises in the Mississippi Black Belt," Unpublished M.S. Thesis, Mississippi State University, 1971.

Appendix Table 15. Estimated annual ownership and operating cost of selected equipment and facilities, Mississippi

ITEM	Size or description	Depreciation	Interest	Fuel	Repairs and Maintenance	Total
		dollars				
Seine storage reel	2,000' capacity	45.00	18.00	--	22.50	85.50
Boat and motor	16' boat--10 h.p. motor	75.00	30.00	13.41 1/	56.25	174.69
Boat trailer	Std. commercial	20.00	8.00	--	8.00	36.00
Line hauler	p.t.o. driven	75.00	30.00	--	37.50	142.50
Snatch block	--	2.00	.80	--	.40	3.20
Crane	25' reach--450 lb. cap.	175.00	140.00	--	175.00	490.00
Seine supports	--	.80	.16	--	--	.96
Seine platform	7' x 20' x 18" with 20 h.p. motor	140.00	56.00	26.88 1/	105.00	327.88
Platform trailer	custom	75.00	30.00	--	30.00	135.00
Haul seine with funnel and hoop	200' section of 10' seine with 1" mesh	70.00	14.00	--	20.00	104.00
Cutting seine	50' section of 6' seine with ½" mesh	16.00	3.20	--	4.00	23.20
Live car	30,000 lb. capacity	37.00	7.40	--	12.00	56.40
Live car	10,000 lb. capacity	26.20	5.24	--	9.00	40.44
Brailing basket	450 lb. capacity	13.00	2.60	--	3.00	18.60
Hauling line	600' spool of 3/4" rope	16.20	3.24	--	--	19.44
Feeder	1,500 lb. capacity	130.00	52.00	--	97.50	279.50
Feed storage	bulk	65.00	26.00	--	32.50	123.50
Service building	18' x 24'	75.00	60.00	--	150.00	285.00
Relift pump	p.t.o. driven--8" high lift with aeration equipment	185.50	74.20	--	92.70	352.40
Tractor	35-46 h.p.	464.58	223.00	656.00	696.00	2,039.58
Truck	1½ ton	625.00	312.50	300.00	500.00	1,737.50
Truck	½ ton	275.00	110.00	240.00	160.00	785.00
Mowing machine	7'	45.50	21.84	--	36.40	103.74

1/Estimated

Source: Developed from data presented in Appendix Table 14.

Appendix Table 16. Estimated cost of levee construction, drainage structures, road surfacing, and vegetative cover, by Farm Situation, Mississippi, 1971.

Item	Farm Situation					
	I	II	III	IV	V	VI
	dollars					
Earth moving	79,154.78	47,595.48	31,818.95	23,916.62	19,968.57	15,954.84
Drainage structures	10,600.00	5,300.00	1,483.25	1,325.00	662.50	662.50
Gravel	12,276.00	8,228.00	6,204.00	6,204.00	5,192.00	4,136.00
Vegetative cover	639.83	464.92	374.81	332.79	310.83	287.74
TOTAL	102,670.61	61,588.40	39,881.01	31,778.41	26,133.90	21,021.08

pendix Table 17. Estimated investment for a 2,000 gallon per minute well,[1/] Mississippi, 1971.

e and Casing		Dollars
sing--60' x 12"	@ $5.00 per ft.	$ 300.00
reen--40' x 12"	@ $10.00 per ft.	400.00
avel--20 yds.	@ $10.00 per yd.	200.00
illing, labor, etc.		1,000.00
		$ 1,900.00
p and Engine		
ump assembly		1,400.00
uction and discharge pipe		50.00
ight angle gear drive		510.00
iesel engine		2,500.00
oicer shaft and flanges		120.00
uel tank--500 gal.		70.00
Subtotal		$ 4,650.00
TOTAL		$ 6,550.00

/he pump is a single stage turbine with a 60-ft.--8-inch column and a 1" haft--water lubricated. Pump will deliver 2,000 g.p.m. 52 feet of total ead requiring 32 h.p. at 1,800 r.p.m.'s.

rce: Mr. Max Harper, Butane Gas Company of Greenwood, Mississippi.

pendix Table 18. Estimated investment for a 3,000 gallon per minute well,[1/] Mississippi, 1971.

l and Casing		Dollars
asing--60' x 16"	@ $6.00 per ft.	$ 360.00
creen--40' x 16"	@ $12.00 per ft.	480.00
ravel--20 yds.	@ $10.00 per yd.	200.00
rilling, labor, etc.		1,060.00
Subtotal		$ 2,100.00
p and Engine		
ump assembly		2,200.00
uction and discharge pipe		50.00
ight angle gear drive		650.00
iesel engine		2,700.00
oicer shaft and flanges		120.00
uel tank--500 gal.		70.00
Subtotal		$ 5,790.00
TOTAL		$ 7,890.00

he pump is a single stage turbine with a 60-ft.--10-inch column and a 3/16 inch shaft--water lubricated. Pump will deliver 3,000 g.p.m. at 8 feet of total head requiring 58 h.p. at 1,800 r.p.m.'s.

rce: Mr. Max Harper, Butane Gas Company of Greenwood, Mississippi.

Appendix Table 19. Estimated well and pipe investment per Farm Situation.

Farm Situation	Well Investment	Pipe Investme
	dollars	
I	38,210.00	5,400.00
II	38,210.00	2,862.00
III	39,450.00	792.00
IV	39,450.00	612.00
V	39,450.00	408.00
VI	39,450.00	225.00

Appendix Table 20. Estimated annual ownership and operating cost[1/] for a 2,000 gallon per minute well, Mississippi, 1971.

ITEM	Cost
Ownership cost	Dollars
Depreciation[2/]	
Well and casing	$ 133.33
Pump assembly	116.67
Suction and discharge pipe	4.17
Right angle gear drive	42.50
Spicer shaft and flanges	10.00
Fuel tank	3.50
Diesel engine	312.50
Interest[3/]	
Well and casing	80.00
Pump assembly	56.00
Suction and discharge pipe	2.00
Right angle gear drive	20.40
Spicer shaft and flanges	4.80
Fuel tank	2.80
Diesel engine	100.00
Operating Cost[1/]	
Repairs and maintenance[4/]	199.50
Total specified cost	$1,088.17

1/Exclusive of fuel and labor cost.

2/Depreciation schedule adapted from W. F. Hughes, Labor Requirements and Cost for Sprinkler Irrigation Texas High Plains, (MP-750, College Station, Texas Agricultural Experiment Station, December 1964), p. 11, with useful life of specific items as follows: wells and casing, 15 yea pump assembly, 12 years; suction and discharge pipe, 12 years; right angle gear, 12 years; spicer shaft and flanges, 12 years; fuel tank, 20 years; and diesel engine, 8 years.

3/Interest computed at rate of eight percent on the average investment.

4/Estimated at 3 percent of investment per year. Adapted from Hughes, op. cit., p. 11.

ppendix Table 21. Estimated annual ownership and operating cost[1/] for a 3,000 gallon per minute well, Mississippi, 1971.

TEM	Cost
wnership cost	Dollars
epreciation[2/]	
Well and casing	140.00
Pump assembly	183.33
Suction and discharge pipe	4.17
Right angle gear drive	54.17
Spicer shaft and flanges	10.00
Fuel tank	3.50
Diesel engine	337.50
nterest[3/]	
Well and casing	84.00
Pump assembly	88.00
Suction and discharge	2.00
Right angle gear drive	26.00
Spicer shaft and flanges	4.80
Fuel tank	2.80
Diesel engine	108.00
perating Cost[1/]	
Repairs and maintenance	236.70
Total specified cost	$1,284.97

/Exclusive of fuel and labor cost

/Depreciation schedule adapted from W.F. Hughes, Labor Requirements and Cost For Sprinkler Irrigation Texas High Plains (MP-750, College Station, Texas Agricultural Experiment Station, December 1964), p. 11, with useful life of specific items as follows: wells and casing, 15 years; pump assembly, 12 years; suction and discharge pipe, 12 years; right angle gear, 12 years; spicer shaft and flanges, 12 years; fuel tank, 20 years; and diesel engine, 8 years.

/Interest computed at rate of eight percent on the average investment.

/Estimated at 3 percent of investment per year. Adapted from Hughes, op. cit., p. 11.

Appendix Table 22. Estimated investment for specialized disease, parasite and weed control equipment, Farm Situations I through V Mississippi, 1971.

Item	Cost
	dollars
Oxygen meter and probe	$ 365.00
Boat (with chemical mixing and applicating chamber)	400.00
Motor - 10 h.p.	425.00
TOTAL	$1,190.00

Source: Manufacturers and local dealers quotations.

Appendix Table 23 Estimated annual ownership and operating cost[1/] for specialized disease, parasite, and weed control equipment, Farm Situations I through VI, Mississippi, 1971

ITEM	Cost
	Dollars
Depreciation	
Oxygen meter and probe (5-year life)	73.00
Boat (10-year life)	40.00
Motor (10-year life)	42.50
Interest	
Oxygen meter and probe	14.60
Boat	16.00
Motor	17.00
Repairs and Maintenance	
Oxygen meter probe	
Batteries - 8 @ $.95 each	7.60
Maintenance kit - 1 @ $10.00 each	10.00
Boat - 40 percent of purchase price over life[2/]	16.00
Motor - 75 percent of purchase price over life[2/]	31.88
Fuel - motor	40.32[2/]
Total specified costs	$308.90

1/Exclusive of labor.

2/Estimated from harvesting data presented in Appendix Tables 14 and 15.

Source: Prices and years life of selected items were obtained from local dealers and manufacturers specifications.

Appendix Table 24. Estimated annual cost for disease, parasite, and weed control per surface acre by Farm Situation, Mississippi, 1971.

ITEM	Farm Situation					
	I	II	III	IV	V	VI
	dollars					
Specialized equipment	308.90	308.90	308.90	308.90	308.90	308.90
Formalin	3.41	3.71	3.89	3.97	4.03	4.06
Potassium permanganate	260.00	270.00	280.25	471.40	852.50	1,736.00
Terramycin	278.57	303.72	318.03	650.31	1,313.13	2,654.84
Copper sulfate	126.36	137.70	144.18	147.42	297.69	601.83
Karmex	46.02	50.15	52.51	53.69	108.41	219.04
TOTAL	$1,023.26	$1,074.18	$1,107.76	$1,635.69	$2,883.26	$5,524.67
Per surface	8.20	7.90	7.78	11.23	19.61	37.18

Appendix Table 25. Farm Situation I: Estimated annual costs of owning and operating harvesting equipment, Mississippi, 1971.[1/]

ITEM	Unit	Quantity	Depreciation	Interest	Fuel	Repairs & maintenance	Total
			dollars				
Haul seine with funnel and hoop	200 ft.	1.0	72.00	14.40	--	20.00	106.40
Haul line (spool)	600 ft.	5.0	81.00	16.20	--	--	97.20
Seine storage reel	--	1.0	45.00	18.00	--	22.50	85.50
Boat and motor	--	1.0	75.00	30.00	13.44	56.25	174.69
Boat trailer	--	1.0	20.00	8.00	--	8.00	36.00
Line hauler	--	1.0	75.00	30.00	--	37.50	142.50
Snatch blocks	--	4.0	8.00	3.20	--	1.60	12.80
Cutting seine	50 ft. 1.	1.0	16.00	3.20	--	4.00	23.20
Seine supports	--	8.0	6.40	1.28	--	--	7.68
Live car (capacity)	10,000 lb.	1.0	26.20	5.24	--	9.00	40.54
Brailing basket	--	1.0	13.00	2.60	--	3.00	18.60
Crane	--	1.0	175.00	140.00	--	175.00	490.00
Miscellaneous[2/]	--	1.0					120.00
Labor	hours	786.24[3/]					1,297.30
Total specified expenses							$2,652.51

1/Does not include truck and tractor costs which are charged to the entire operation.

2/Includes three pairs of waders and three dip nets.

3/Hired labor at $1.65 per hour.

Appendix Table 26 Farm Situation II: Estimated annual costs of owning and operating harvesting equipment Mississippi, 1971.—

ITEM	Unit	Quantity	Depreciation	Interest	Fuel	Repairs & Maintenance	Total
			----------	----------	Dollars	----------	----------
Haul seine with funnel and hoop	200 ft.	1.0	72.00	14.40	--	20.00	106.40
Haul seine without funnel and hoop	200 ft.	1.5	87.50	17.50	--	25.00	130.00
Haul line (spool)	600 ft.	6.0	97.20	19.44	--	--	116.64
Storage reel	--	1.0	45.00	18.00	--	22.50	85.50
Boat and motor	--	1.0	75.00	30.00	13.44	56.25	174.69
Boat trailer	--	1.0	20.00	8.00	--	8.00	36.00
Line hauler	--	1.0	75.00	30.00	--	37.50	142.50
Snatch blocks	--	4.0	8.00	3.20	--	1.60	12.80
Cutting seine	50 ft. l.	1.0	16.00	3.20	--	4.00	23.20
Seine supports	--	10.0	8.00	1.60	--	--	9.60
Live car (capacity)	30,000 lb.	1.0	37.00	7.40	--	12.00	56.40
Brailing basket	--	1.0	13.00	2.60	--	3.00	18.60
Crane	--	1.0	175.00	140.00	--	175.00	490.00
Miscellaneous 2/		1.0					120.00
Labor	hours	561.92 3/					927.17
Total specified expenses							$2,349.50

1/Does not include truck and tractor costs which are charged to the entire operation.

2/Includes three pairs of waders and three dip nets.

3/Hired labor at $1.65 per hour.

Appendix Table 27. Farm Situation III: Estimated annual costs of owning and operating harvesting equipment, Mississippi, 1971.[1/]

ITEM	Unit	Quantity	Depreciation	Interest	Fuel	Repairs & Maintenance	Total
			----------	----------	Dollars	----------	----------
Haul seine with funnel & hoop	200 ft.	1.0	72.00	14.40	--	20.00	160.40
Haul seine without funnel & hoop	200 ft.	4.0	280.00	56.00	--	80.00	356.00
Haul line (spool)	600 ft.	7.0	113.40	22.68	--	--	136.08
Storage reel	--	1.0	45.00	18.00	--	22.50	85.50
Boat and motore	--	1.0	75.00	30.00	13.44	56.25	174.69
Boat trailer	--	1.0	20.00	8.00	--	8.00	36.00
Line hauler	--	1.0	75.00	30.00	--	37.50	142.50
Snatch blocks	--	4.0	8.00	3.20	--	1.60	12.80
Cutting seine	--	1.0	16.00	3.20	--	4.00	23.20
Seine supports	--	20.0	16.00	3.20	--	--	19.20
Live cars (capacity)	30,000 lb.	2.0	37.00	14.80	--	24.00	112.80
Brailing basket	--	1.0	13.00	2.60	--	3.00	18.60
Crane	--	1.0	175.00	140.00	--	175.00	490.00
Miscellaneous[2/]	--	1.0					120.00
Labor	hours	530.16[3/]					874.76
Total specified expenses							$2,708.53

1/Does not include truck and tractor costs which are charged to the entire operation.

2/Includes three pairs of waders and three dip nets.

3/Hired labor at $1.65 per hour.

Mississippi, 1971.1/

ITEM	Unit	Quantity	Depreciation	Interest	Fuel	Repairs & Maintenance	Total
			----------	----------	Dollars	----------	----------
Haul seine without funnel and hoop	200 ft.	10.0	700.00	140.00	--	200.00	1,040.00
Haul line (spool)	600 ft.	10.0	162.00	32.40	--	--	194.40
Storage reel	--	1.0	45.00	18.00	--	22.50	85.50
Boat and motor	--	1.0	75.00	30.00	13.44	56.25	174.69
Trailer	--	1.0	20.00	8.00	--	8.00	36.00
Seine platform and motor	--	1.0	140.00	56.00	26.88	105.00	327.88
Seine platform trailer	--	1.0	75.00	30.00	--	30.00	135.00
Line hauler	--	1.0	75.00	30.00	--	37.50	142.50
Snatch blocks	--	6.0	12.00	8.00	--	4.00	24.00
Seine supports	--	40.0	32.00	6.40	--	--	38.40
Cutting seine	50 ft. l.	2.0	32.00	6.40	--	8.00	46.40
Brailing basket	--	1.0	13.00	2.60	--	3.00	18.60
Crane	--	1.0	175.00	140.00	--	175.00	490.00
Miscellaneous2/	--	1.0					160.00
Labor	hours	1,032.963/					1,704.38
Total specified expenses							$4,617.75

1/Does not include truck and tractor costs which are charged to the entire operation.

2/Includes four pairs of waders and four dip nets.

3/Hired labor at $1.65 per hour.

Appendix Table 29. Farm Situation V: Estimated annual costs of owning and operating harvesting equipment, Mississippi, 1971.[1/]

ITEM	Unit	Quantity	Depreciation	Interest	Fuel	Repairs & Maintenance	Total
			----------	----------	Dollars	----------	----------
Haul seine without funnel and hoop	200 ft.	10.0	700.00	140.00	--	200.00	1,040.00
Haul line (spool)	600 ft.	14.0	226.80	45.36	--	--	272.16
Storage reel	--	1.0	45.00	18.00	--	22.50	85.50
Boat and motor	--	1.0	75.00	30.00	13.44	56.25	174.69
Trailer	--	1.0	20.00	8.00	--	8.00	36.00
Seine platform and motor	--	1.0	140.00	56.00	26.88	105.00	327.88
Seine platform trailer	--	1.0	75.00	30.00	--	30.00	135.00
Line hauler	--	1.0	75.00	30.00	--	37.50	142.50
Snatch blocks	--	10.0	20.00	8.00	--	4.00	32.00
Seine supports	--	40.0	32.00	6.40	--	--	38.40
Cutting seine	50 ft. l.	2.0	32.00	6.40	--	8.00	46.40
Brailing basket	--	1.0	13.00	2.60	--	3.00	18.60
Crane	--	1.0	175.00	140.00	--	175.00	490.00
Miscellaneous[2/]	--	1.0					160.00
Labor	hours	979.46[3/]					1,616.11
Total specified expenses							$4,615.24

1/Does not include truck and tractor costs which are charged to the entire operation.

2/Includes four pairs of waders and four dip nets.

3/Hired labor at $1.65 per hour

Appendix Table 30. Farm Situation VI: Estimated annual costs of owning and operating harvesting equipment, Mississippi, 1971.[1/]

ITEM	Unit	Quantity	Depreciation	Interest	Fuel	Repairs & Maintenance	Total
			----------	----------	Dollars	----------	----------
Haul seine without funnel & hoop	200 ft.	19.0	1,330.00	266.00	--	380.00	1,976.00
Haul line (spool)	600 ft.	20.0	324.00	64.80	--	--	388.80
Storage reel	--	2.0	90.00	36.00	--	45.00	171.00
Boat and motor	--	1.0	75.00	30.00	13.44	56.25	174.69
Trailer	--	1.0	20.00	8.00	--	8.00	36.00
Seine platform and motor	--	1.0	140.00	56.00	26.88	105.00	327.88
Seine platform trailer	--	1.0	75.00	30.00	--	30.00	135.00
Line hauler	--	1.0	75.00	30.00	--	37.50	142.50
Snatch blocks	--	10.0	20.00	8.00	--	4.00	32.00
Seine supports	--	80.0	32.00	6.40	--	--	38.40
Brailing basket	--	1.0	13.00	2.60	--	3.00	18.60
Cutting seine	50 ft. l.	2.0	32.00	6.40	--	8.00	46.40
Crane	--	1.0	175.00	140.00	--	175.00	490.00
Miscellaneous[2/]		1.0					240.00
Labor	hours	1,347.15[3/]					2,222.80
Total specified expenses							$6,440.07

1/Does not include truck and tractor costs which are charged to the entire operation.

2/Includes six pairs of waders and three dip nets.

3/Hired labor at $1.65 per hour.

Appendix Table 31. Estimated annual costs of selected items for Farm Situations I through VI, Mississippi, 1971.

Item	Annual cost
	dollars
Taxes (163 acres, @ $.70 per acre)[1/]	$114.10
Bookkeeping and Accounting[2/]	205.00
General Office Overhead[2/]	192.00
Insurance[3/]	258.00
TOTAL	$769.10

1/ U.S.D.A. Farm Real Estate Taxes (ERS RET-10, Washington: U.S. Governme Printing Office, February 1971), p. 6.

2/ Garner, Carroll R., "Estimated Investment Requirements, Costs, and Returns for Five Sizes of Catfish Farms in Southeastern Arkansas," (unpublished M.S. thesis, Fayetteville: University of Arkansas, January 1971), p. 89.

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DORMANRED RASPBERRY: A NEW VARIETY FOR MISSISSIPPI

MISSISSIPPI STATE UNIVERSITY
AGRICULTURAL AND FORESTRY EXPERIMENT STATION
JAMES H. ANDERSON, Director
STATE COLLEGE MISSISSIPPI

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This Dormanred Cane tip (above) rooted, then produced a new cane or shoot the next spring.

DORMANRED RASPBERRY: NEW VARIETY FOR MISSISSIPPI

By Dr. J. P. OVERCASH,
MAFES Horticulturist

A new cultivar (variety) of red raspberries is being released to nurserymen and home owners for propagation and distribution. This cultivar is well adapted in Mississippi. It makes large, healthy plants with trailing canes which produce abundant, terminal fruit clusters of large berries the second year after planting.

Dormanred has been tested as a selection at Mississippi State University and observed at other locations in Mississippi, Alabama, Louisiana, and Georgia. Plant vigor, fruit size and productivity have been reported favorable in all locations. It is now recommended for trial in home gardens throughout Mississippi and in neighboring states with similar climatic conditions.

The Dormanred raspberry is named after Dr. Clarence Dorman, a former Director of the Mississippi Agricultural and Forestry Experiment Station, who proposed that the author initiate a breeding program to develop red raspberries adapted to southern growing conditions. A pint basket of this attractive, large-fruited cultivar is shown on the cover.

Raspberry plants have perennial underground crowns which produce biennial above-ground canes. A new shoot growth from the crown is called a cane, and it may grow to as much as $\frac{1}{4}$ to $\frac{1}{2}$ inch in diameter near its base by the end of the first growing season. Dormanred canes often grow 6 to 10 feet long in one growing season.

The second spring, flowering shoots arise from lateral buds on these canes and produce fruits. After the fruits are ripe, the cane dies and should be cut out and removed. New canes arising from the crown in early spring or summer will produce fruit the next year.

Ancestry of Dormanred

When the early settlers arrived in North America from Europe, they commonly brought with them seeds, cuttings or trees of the fruits which they were accustomed to growing in Europe. Botanically, the European red raspberry belongs to the species **Rubus idaeus**, and was brought to the northern part of the United States by early settlers, where it was fairly well adapted.

In 1865 a chance seedling was found in the area of present-day New York City and was named Cuthbert. It was believed that the female parent was the European cultivar, Hudson River Antwerp, and the male parent was the wild native American red raspberry of the **R. strigosus** species, which was growing nearby. This cultivar was eventually involved in the Mississippi breeding program.

Cultivars of raspberries commonly available in recent years from commercial fruit plant nurseries in the United States have not proven suitable in Mississippi. The native red raspberries of North America are of the **R. strigosus** species and are found growing wild throughout the northeastern United States and at higher elevations in the mountains as far south as North Carolina.

Neither the plants of this wild species, the European cultivars or the hybrids of these red raspberries grow well in the southern states.

Plant breeders of the United States Department of Agriculture, during the period 1920 to 1940, collected raspberry species indigenous throughout the world in climates similar to the southern states. Some of the species exhibited excellent plant growth and vigor. But, the fruit qualities were inferior to those of the native American or European red raspberries, or their hybrids.

In 1928, Mr. C. F. Williams began a hybridization program with red raspberries at the North Carolina Agricultural Experiment Station. Then the raspberry testing and breeding program was started

in Mississippi in 1946, and a number of species and hybrids which had shown good climatic adaptation to eastern North Carolina were obtained. These became the foundation for a breeding program.

Many interspecific hybrids were produced and grown until they fruited. The good plant vigor exhibited by several species from the Orient was easy to maintain in hybrids with named cultivars of commercial American raspberries, but good fruit qualities proved more difficult to obtain in hybrids.

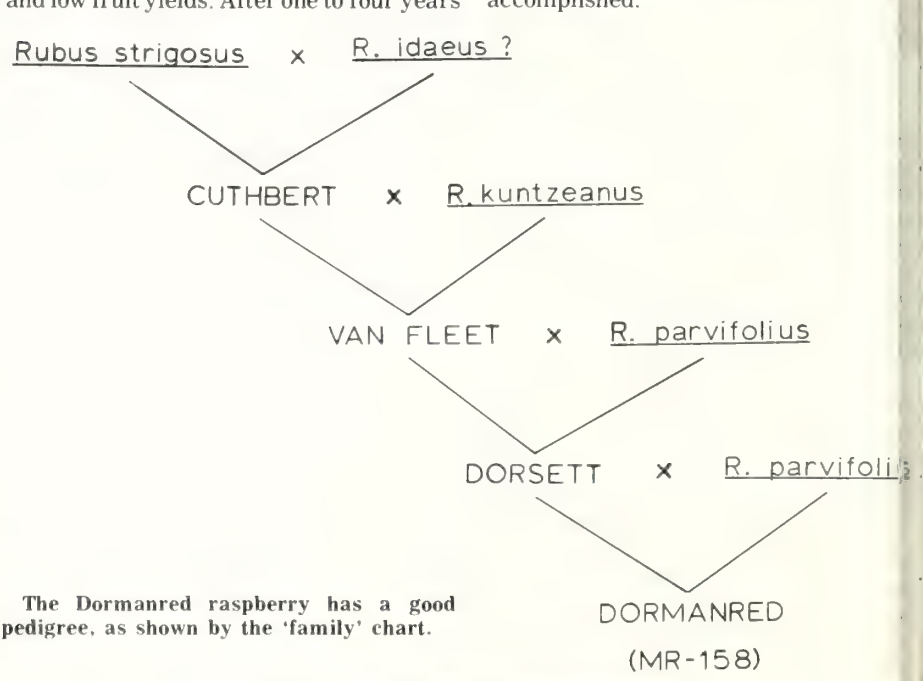
Cultivar tests were conducted for several years with clones such as: Chief, Cuthbert, Early Wonder, Flaming Giant, Indian Summer, Latham, Lloyd George, Milton, Newburgh, St. Regis, Sunbeam, Sunrise, Tahoma, Taylor, Washington and Willamette. These were grown under ideal conditions with straw mulches, fungicide and insecticide sprays and adequate fertilization.

Even under these conditions, many of these cultivars made poor plant growth and low fruit yields. After one to four years the stand of plants diminished and y lds were unacceptably low. The hot wea er and periods of summer drought st ss apparently contributed to their or performance and decline.

In 1949 a cross was made between he species, **R. parvifolius** (N. C. 60), and he Dorsett (USDA) cultivar. The pedi ee included several red raspberry spe ies and is shown below.

Plants of both parents in this cross l ve trailing canes. Many hybrid plants w re vigorous and had varying degree of coherence of the drupelets (segme s) which make up the berries.

One hybrid was numbered Mississ pi Raspberry No. 158 (MR 158) and as subsequently propagated and teste in field plots. It is now being named or- manred. The naming and release of is cultivar were delayed in hopes of developing another cultivar with upr ht canes and similar fruit productivity, f it size and plant vigor, but this has not b en accomplished.



The Dormanred raspberry has a good pedigree, as shown by the 'family' chart.

Figure 2. Pedigree of the new Dormanred raspberry.

Raspberry plants trained on a two-wire vertical trellis give a comparison between two rieties. At left is the largest of three Latham variety raspberries which survived, of 30 anted. At right are vigorous, heavily-leafed Dormanred raspberries.

Raspberries, or blackberries, with rocumbent (trailing) canes are)mewhat more difficult to manage in eld production than those with upright anes. The trailing canes must be tied to a ake or trellis as they grow, so the soil can e cultivated or mulched. Futhermore, ven under mulch management the canes eed to be up in the air to protect the fruits om the soil and soil-borne pathogens.

The Dormanred cultivar has been grown n several replicated tests, beginning in 964. Raspberry plants in these tests were rown in rows 6 or 8 feet apart to make ultivation easier. Plot length was 15 feet nd plant spacing was 3 feet in the rows. Three wire, vertical trellises about 5 feet all were provided to support the plants as eeded. Thin pliable wire or cotton string vas used to attach the canes. These tests nvolved other promising selections from he breeding program and one or more amed, commercially available cultivars.

Latham was the only cultivar used in all tests and comparisons of plants and fruits of Dormanred, and it will be discussed in this bulletin.

In one test with six blocks of five plants each (spaced three feet apart in the row) plots were planted with three varieties and two selections. After 18 months in the field, 100 percent of the Dormanred variety plants were alive and healthy, but only 10 percent of the Latham plants were alive, and all the plants of the other two varieties had died.

At that time there was an average of 8.5 canes per hill of Dormanred, but only 3.5 canes per surviving hill of Latham. The average length of canes for Dormanred was 87 inches; for Latham, the canes averaged only 43 inches. Total length of canes per hill for Dormanred was 2,793 inches, for Latham only 282 inches. The Dormanred canes were limber and had to be tied to a trellis regularly throughout the

Table 1. Production, in pints, per 15 feet of row, of 2 raspberry cultivars in a test with 6 replications at State College, Mississippi.

Fruiting Season	Latham	MR 58
1st year	.2	.2
2nd year	.1	.8
3rd year	.2	1.8
4th year	--	1.7

summer while the Latham canes were upright and needed tying only twice in a typical summer. The picture on page 5 shows size comparisons of the best Latham planted and a Dormanred plant in June of the second summer in the field.

Fruits of the Dormanred were very large, with an average diameter of 1.86 centimeters, whereas Latham fruits averaged only 1.3 cm. (a centimeter is about two-fifths of an inch.) Fruits of both cultivars are somewhat flattened with a height of 1.24 cm. for Dormanred and .9 cm. for Latham.

A pint of Dormanred raspberries weighed about 340 grams (three fourths of a pound) and contained about 150 fruits while a pint basket of Latham weighing 340 grams contained about 230 fruits. Fruits of Dormanred are usually borne in terminal clusters of 8-20 berries as shown here. The fruits have a glossy, deep red color.

The raspberry fruit has a hollow core when it is picked or removed from the receptacle of the fruit stem. The fruit is botanically called an aggregate and is composed of drupes each of which has a seed in a fleshy segment. Dormanred fruits averaged 44 drupes per fruit while Latham fruits averaged 65 drupes.

Latham plants seldom survived in test plots and the yield per plot was very low. Even the more vigorous Latham "hills" seldom produced more than a pint pe Table 1 gives yield from a test in v three plants of Latham lived throug third fruiting season. Thirty Dorma plants maintained good plant vigor fruit productivity.

European, as well as native Amer red raspberries produce suckers shoots) arising from roots. These su form a hedge row in a field for production, but can be dug and t

Right: A terminal fruit cluster of Dormanred raspberry, with the leaves removed to show the fruits.

ted to a new field. The Dormanred berry does not ordinarily form ers and the plants remain in hills like berry plants. The propagation of hanred is either by "tip layering" in all or from leafy stem cuttings in the propagation bed throughout the mer.

e natural propagation of Dormanred rs in late September or October. The of the canes become somewhat ened and the tip may become as thick n ordinary lead pencil, while the al leaves remain small like a mouse They will root readily if exposed to t soil for a few days.

e picture on the inside front cover s a typical rooted tip which has uced a new shoot from its crown . For propagation purposes, a grower et plants in the spring for propagation utting them in rows and pinching the out of the canes every one to three s, to induce the maximum number of iple branches. In the fall, the ready- ot tips can be covered with moist soil asten rooting.

oting may begin in September and nue throughout the fall and during n periods in winter. Roots on in- ual plants may become six inches or longer, by spring. The old cane can t six inches long for a bundle and the plants are dug and transplanted in h or early April before the new shoots . The roots will continue to grow and a cane will form from the crown of the plant and make rapid growth.

e second method of propagation is by inal, leafy stem cuttings beginning in or June and continuing throughout summer and fall. These should be 5 or 6 es long, with one or two immature es left at their terminal. The basal cut ld be just below a a leaf attachment on the stem.

ttings should not be permitted to wilt, should be spaced 1 to 3 inches apart in sandy medium under intermittent . The basal area may be treated with t promoting" chemicals. Under good agating conditions, from 90 to 100 percent of the cuttings will form roots in 4 to 6 weeks, as shown on this page. They are then transplanted to pots and grown there for the rest of the summer and transplanted to the field the next spring.

Nurserymen or home gardeners who are interested in growing this new raspberry may contact the author at: Department of Horticulture, Mississippi Agricultural and Forestry Experiment Station, State College, Mississippi 39762. A limited supply of small plants are available this spring.

Dormanred raspberry cutting after six weeks in a mist propagation bed.

Bulletin 794
July 1972

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Enterprises

in the YAZOO-MISSISSIPPI DELTA

By Fred T. Cooke, Jr., J. M. Anderson, and Arthur M. Heagler

MISSISSIPPI AGRICULTURAL AND
FORESTRY EXPERIMENT STATION
James H. Anderson, Director

in cooperation with
Farm Production Economics Division
Economic Research Service
U. S. Department of Agriculture

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Bulletin 794

CROP BUDGETS AND PLANNING DATA FOR MAJOR FARM ENTERPRISES IN THE YAZOO-MISSISSIPPI DELTA

By
Fred T. Cooke, Jr., J. M. Anderson, and Arthur M. Heagler

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ACKNOWLEDGEMENTS

During the preparation of the material contained in this report substantial use w made of an earlier publication by the Delta Farm Management Committee, "Budge for Major Farm Enterprises in the Mississippi River Delta of Arkansas, Louisiana, a Mississippi," AEc. M.R. No. 30, Miss. Agric. Expt. Sta., 1961. The authors expre their appreciation to Bill Bolton, James G. Hamill, J. B. Penn, and James H. Whi who, as members of the Delta Farm Management Committee, made continuing ,cont butions to this effort.

Special appreciation is extended to the farm cooperators for their willing coope tion in providing the basic data in this publication.

CROP BUDGETS AND PLANNING DATA FOR MAJOR FARM ENTERPRISES IN THE YAZOO-MISSISSIPPI DELTA

By

Fred T. Cooke, Jr., J. M. Anderson, and Arthur M. Heagler [1/]

This publication has been prepared for the explicit purpose of providing production practices employed and production costs incurred for various crops grown in the Delta area of Mississippi. Current practices and production costs associated with various agricultural enterprises are routinely needed by researchers, farmers, extension specialists, and others working in agriculture.

Procedures outlined by leading economists in the early 1950's called for obtaining solutions to linear programming problems by hand calculations. Matrices optimized with these techniques were necessarily simple and relatively small. Recent advancements in computer technology have increased the range of problem-complexity which can be dealt with computationally. Relatively short calculation times are now required for achieving desired solutions.

One aspect of linear programming which probably has not received adequate attention is the basic technical coefficients used to determine an optimum solution. A characteristic of agricultural production functions is continual change, hence, basic input data for optimum solutions must be constantly reviewed to reflect currently applied technologies.

Procedure

Data on practices and machinery performance rates were collected in three different ways. From 1965 to 1967, 64 farm cooperators kept detailed records on each practice used to produce a cotton and soybean crop on one field for each crop on each cooperating farm.[2/] These data were supplemented with a survey of 110 farms in 1967 and 216 farms in 1968. Excluding the 64 original cooperating farmers, cooperators for both 1967 and 1968 were selected at random from all farms with more than 500 acres of cropland in the Delta area of Mississippi. The findings from 1965 through 1968 were verified and updated in 1969 and 1970 by interviews with selected farmers.

Corn and milo production is not widespread in the Delta area. Thus the budgets presented in this report incorporate information from a limited number of producers and data from experiment station reports. Therefore, the information for these two crops cannot be considered with the same degree of confidence as the other budgets in this report.

Machinery prices used in this report were obtained from seven retail tractor dealerships in the Delta area during 1969. These prices reflect prices paid to dealers

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1/ Agricultural Economist, FPED, ERS, USDA, stationed at Stoneville, Miss., Agricultural Economist, Delta Branch of the Miss. Agri. and Forestry Expt. Sta., Stoneville, Miss., and Agricultural Economist, FPED, ERS, USDA, stationed at Baton Rouge, La., respectively.

2/ Cooke, Jr., Fred T., "Delta Producers Launch Drive for Efficiency," **Cotton International Edition,** 1969, Meister Publishing Company, Memphis, Tenn., pp. 68-69.

Table 1. Power and machinery performance rates, estimated life, price and repairs as a percentage of new cost, Delta area of Mississippi, 1969.

Implement	Size or description	Performance rate per acre	Years of life	Average hours of annual use	Total hours of life	1969 price	Repairs as a percentage of new cost 1/
		Hours	Years	Hours	Hours	Dollars	Percent
Tractor	40 HP	--	12	1,000	12,000	4,100	120
Tractor	60 HP	--	12	1,000	12,000	6,380	100
Tractor	80 HP	--	12	1,000	12,000	8,100	93
Tractor	100 HP	--	12	1,000	12,000	11,800	79
Stalk shredder	2-row	.30	10	185	1,850	420	40
Stalk shredder	4-row	.24	10	185	1,850	980	40
Middle breaker	3-row	.40	12	160	1,920	950	80
Middle breaker	4-row	.24	12	160	1,920	1,200	80
Middle breaker	6-row	.14	12	160	1,920	1,950	80
Rolling bedder	2-row	.40	8	160	1,280	460	80
Rolling bedder	4-row	.20	8	160	1,280	810	80
Rolling bedder	6-row	.13	8	160	1,280	1,390	80
Moldboard plow (2-way)	3-bottom	.42	15	120	1,800	1,115	80
Moldboard plow (2-way)	4-bottom	.33	15	120	1,800	1,530	80
Disk harrow	7 ft.	.45	10	180	1,800	550	80
Disk harrow	14 ft.	.23	10	180	1,800	1,660	80
Disk harrow	21 ft.	.14	10	180	1,800	2,680	80
Section harrow	4-row	.20	10	200	2,000	500	70
Section harrow	6-row	.10	10	200	2,000	830	70
Soil pulverizer	4-row	.20	12	100	1,200	985	70
Soil pulverizer	6-row	.15	12	100	1,200	1,668	70
Subsoiler	1-row	1.00	15	100	1,500	310	100
Subsoiler	2-row	.65	15	100	1,500	400	100
Solid fertilizer applicator	4-row	.28	10	120	1,200	610	70
Solid fertilizer applicator	6-row	.21	10	120	1,200	880	70
Rolling buster with ammonia applicator	4-row	.23	8	160	1,280	1,415	80
Rolling buster with ammonia applicator	6-row	.16	8	160	1,280	2,150	80

1/ Based on [illegible] Survey.

1/ Based on unpublished information obtained from the 1964 National Cost of Producing Cotton Survey, estimated life, value and repairs as a percentage of new cost, Delta area of Mississippi, 1969.

Implement	Size or description	Performance rate per acre	Years of life	Average hours of annual use	Total hours of life	1969 price	Repairs as a percentage of new cost 1/
		Hours	Years	Hours	Hours	Dollars	Percent
Grain drill	14 ft.	.20	12	100	1,200	1,155	70
Chisel plow	7 ft.	.50	12	150	1,800	535	70
Chisel plow	12 ft.	.30	12	150	1,800	720	70
Chisel plow	14 ft.	.24	12	150	1,800	905	70
Chisel plow	18 ft.	.16	12	150	1,800	1,470	70
Planter-cotton-with preemerge rig	2-row	.32	12	100	1,200	870	70
Planter-cotton-with preemerge rig	4-row	.24	12	100	1,200	1,525	70
Planter-cotton-with preemerge rig	6-row	.18	12	100	1,200	1,990	70
Planter-soybean	4-row	.20	12	100	1,200	1,210	70
Planter-soybean	6-row	.15	12	100	1,200	1,850	70
Cultivator-early	2-row	.35	12	200	2,400	600	80
Cultivator-late	2-row	.30	12	200	2,400	600	80
Cultivator-early	4-row	.25	12	200	2,400	890	80
Cultivator-late	4-row	.20	12	200	2,400	890	80
Cultivator-early	6-row	.21	12	200	2,400	1,420	80
Cultivator-late	6-row	.14	12	200	2,400	1,420	80
Cultivator with post-emerge rig-early	4-row	.28	12	200	2,400	1,140	80
Cultivator with post-emerge rig-late	4-row	.24	12	200	2,400	1,140	80
Cultivator with post-emerge rig-early	6-row	.24	12	200	2,400	1,730	80
Cultivator with post-emerge rig-late	6-row	.18	12	200	2,400	1,730	80
Spraying equipment tractor mounted	8-row	.20	8	350	2,800	350	100
Spraying equipment high clearance	12-row	.10	8	350	2,800	4,510	80

1/ Based on unpublished data from repair information obtained from the 1964 National Cost of Producing Cotton Survey.

Table 1, continued. Power and machinery performance rates, estimated life, price and repairs as a percentage of new cost, Delta area of Mississippi, 1969.

Implement	Size or description	Performance rate per acre	Years of life	Average hours of annual use	Total hours of life	1969 price	Repairs as a percentage of new cost 1/
		Hours	Years	Hours	Hours	Dollars	Percent
Forage harvester							
Corn silage	2-row	1.00	10	100	1,000	4,100	80
Milo silage	2-row	0.70	10	100	1,000	4,100	80
Small grain silage	2-row	0.34	10	100	1,000	4,100	80
Cottonpicker							
first picking	1-row	1.30	10	200	2,000	2/7,300	75
second picking	1-row	1.00	10	200	2,000	2/7,300	75
Cottonpicker							
first picking	2-row	.83	10	200	2,000	22,500	75
second picking	2-row	.62	10	200	2,000	22,500	75
Combine - soybean	14 ft.	.33	8	200	1,600	12,100	80
Combine - rice	14 ft.	.95	8	200	1,600	14,600	80
Combine - corn	14 ft.	.50	8	200	1,600	12,700	80
Cotton trailer	6 bale	--	12	200	2,400	1,100	80
Grain cart	--	--	12	200	2,400	1,200	80
Land plane	40 x 10	--	20	120	2,400	1,500	60
Forage wagon	--	--	15	100	1,500	2,060	60
Forage blower	--	--	15	100	1,500	1,240	50

1/ Based on unpublished data from repair information obtained from the 1964 National Cost of Producing Cotton Survey.

2/ Does not include cost of a power unit.

ar not list prices. Spot checks with farm machinery dealers and producers during 1971 indicate that the effective prices for most pieces of equipment have not changed substantially since 1969. Table 1 contains power and machinery performance rates, estimated life, price, and estimated repair costs for various implements found on Delta farms. Table 2 contains direct and fixed costs per hour and per acre, as appropriate, for specified sizes of farm equipment. The interest rate on fixed investment was assumed to be 7.5% per year.

Prices for seed, fertilizer, herbicides, and insecticides were obtained from area dealers in 1970 and are shown in Table 3.

Practices

Two levels of practices are presented in this report for cotton and soybeans. The level of practices will be referred to as "usual practices". "Usual practices" reflect a combination of modal and mean situations. When the modal could satisfactorily describe a practice or input it was used. Many inputs varied too much for modal values to be meaningful. In these instances the mean was used to determine a practice or quality of an input.

The second level of practices represents an effort to describe practices used by those farmers who were producing cotton or soybeans on more efficient production functions than the average farmer. These producers were achieving essentially the same yields as the average farmer but were utilizing fewer, or lower cost inputs to achieve these yields. The budgets for this group will be identified in this report as "more efficient practices". More efficient practices are not presented for small grains, corn, or grain sorghum as sufficient observations were not obtained to provide a reliable separation of production practices for these crops.

Returns

Calculations of returns, while a necessary item in a complete economic analysis, was beyond the intended scope of this effort. The following formula provides a general format for completing this portion of the analyses while permitting flexibility in the choice of soil type, equipment size, planting pattern, technology level, yield per acre, and price of output:

Net returns per acre above specified direct costs	=	Yield per acre	x	price per unit of yield	-	Total specified costs	-	Interest on operating capital

Total specified costs are contained in appropriately defined tables in this publication. These total specified costs do not include general farm overhead items, land charge, management costs, or off-farm costs such as cotton ginning or grain storage. Average yields and yield ranges for the various crops by soil type and planting patterns are shown in Table 4. It is left for the reader to provide and complete the remainder of the return formula. Since silages are intermediate crops, calculation of returns to these crops requires an end product budget in order to be comparable to cotton, soybeans, and other marketable commodity crops.

Budgets

Budgets are presented for two major soil groups: (1) sandy loam through silty clay loams referred to in the tabular material as "sandy" soils, and (2) silty clay and clay soils referred to collectively as "clay" soils. Budgets are also included for 4- and 6-row equipment. The effects of equipment size on specified direct cot-

Table 2. Direct and fixed costs per hour and per acre for specified farm equipment, Delta area of Mississippi, 1969.

Implement	Size or description	Direct costs per hour			Fixed costs per hour			Direct costs per acre	Fixed costs per acre
		Repairs	Fuel	Total	Depreciation	Interest	Total		
		Dollars			Dollars			Dollars	Dollars
Tractor	40 HP	.41	.53	.94	.34	.15	.49	--	--
Tractor	60 HP	.53	.69	1.22	.53	.24	.77	--	--
Tractor	80 HP	.63	.92	1.55	.68	.30	.98	--	--
Tractor	100 HP	.78	1.10	1.88	.98	.44	1.42	--	--
Stalk shredder	2-row	.09	--	.09	.23	.08	.31	.03	.09
Stalk shredder	4-row	.21	--	.21	.53	.20	.73	.05	.18
Middle breaker	3-row	.40	--	.40	.49	.22	.71	.16	.28
Middle breaker	4-row	.50	--	.50	.62	.28	.90	.12	.22
Middle breaker	6-row	.81	--	.81	1.02	.46	1.47	.11	.21
Rolling bedder	2-row	.29	--	.29	.36	.11	.47	.12	.19
Rolling bedder	4-row	.51	--	.51	.63	.19	.82	.10	.16
Rolling bedder	6-row	.87	--	.87	1.09	.33	1.42	.11	.18
Moldboard plow (2-way)	3-bottom	.50	--	.50	.62	.35	.97	.21	.41
Moldboard plow (2-way)	4-bottom	.68	--	.68	.85	.48	1.33	.22	.44
Disk harrow	7 ft.	.24	--	.24	.31	.11	.42	.11	.19
Disk harrow	14 ft.	.74	--	.74	.92	.35	1.27	.17	.29
Disk harrow	21 ft.	1.19	--	1.19	1.49	.56	2.05	.17	.29
Section harrow	4-row	.18	--	.18	.25	.09	.34	.04	.07
Section harrow	6-row	.29	--	.29	.42	.16	.58	.03	.06
Soil pulverizer	4-row	.58	--	.58	.82	.37	1.19	.12	.24
Soil pulverizer	6-row	97	--	.97	1.39	.63	2.02	.14	.30
Subsoiler	1-row	21	--	.21	.21	.12	.33	.21	.33
Subsoiler	2-row	.27	--	.27	.27	.15	.42	.18	.27
Solid fertilizer applicator	4-row	.36	--	.36	.51	.19	.70	.10	.20
Solid fertilizer applicator	6-row	.51	--	.51	.73	.28	1.01	.11	.21
Rolling buster with ammonia applicator	4-row	.88	--	.88	1.10	.33	1.43	.20	.33
Rolling buster with ammonia applicator	6-row	1.34	--	1.34	1.68	.50	2.18	.21	.35
Cultipacker	20 ft.	40	--	40	57	34	91	06	13

Table 3.--Continued. Direct and fixed costs per hour and per acre for specified farm equipment, Delta area of Mississippi, 1969.

Implement	Size or description	Direct costs per hour			Fixed costs per hour			Direct costs per acre	Fixed costs per acre
		Repairs	Fuel	Total	Depreciation	Interest	Total		
		Dollars				Dollars		Dollars	Dollars
Grain drill	14 ft.	.67	--	.67	.96	.43	1.39	.13	.28
Chisel plow	7 ft.	.21	--	.21	.30	.13	.43	.11	.22
Chisel plow	12 ft.	.28	--	.28	.40	.18	.58	.08	.17
Chisel plow	14 ft.	.35	--	.35	.50	.23	.73	.08	.18
Chisel plow	18 ft.	.57	--	.57	.82	.37	1.19	.09	.19
Planter-cotton-with preemerge rig	2-row	.51	--	.51	.72	.33	1.05	.16	.34
Planter-cotton-with preemerge rig	4-row	.89	--	.89	1.27	.57	1.84	.21	.44
Planter-cotton-with preemerge rig	6-row	1.16	--	1.16	1.66	.75	2.41	.21	.43
Planter-soybean	4-row	.71	--	.71	1.01	.45	1.46	.14	.29
Planter-soybean	6-row	1.08	--	1.08	1.54	.69	2.23	.16	.33
Cultivator-early	2-row	.20	--	.20	.25	.11	.36	.07	.13
Cultivator-late	2-row	.20	--	.20	.25	.11	.36	.06	.11
Cultivator-early	4-row	.30	--	.30	.37	.17	.54	.08	.14
Cultivator-late	4-row	.30	--	.30	.37	.17	.54	.06	.11
Cultivator-early	6-row	.47	--	.47	.59	.27	.86	.10	.18
Cultivator-late	6-row	.47	--	.47	.59	.27	.86	.07	.12
Cultivator with post-emerge rig-early	4-row	.38	--	.38	.48	.21	.69	.11	.19
Cultivator with post-emerge rig-late	4-row	.38	--	.38	.48	.21	.69	.09	.17
Cultivator with post-emerge rig-early	6-row	.58	--	.58	.72	.32	1.04	.14	.25
Cultivator with post-emerge rig-late	6-row	.58	--	.58	.72	.32	1.04	.10	.19
Spraying equipment tractor mounted	8-row	.12	--	.12	.12	.04	.16	.02	.03
Spraying equipment high clearance	12-row	1.29	.51	1.80	1.61	.48	2.09	.18	.21

Table 2, continued. Direct and fixed costs per hour and per acre for specified farm equipment, Delta area of Mississippi, 1969.

Implement	Size or description	Direct costs per hour			Fixed costs per hour			Direct costs per acre	Fixed costs per acre
		Repairs	Fuel	Total	Depreciation	Interest	Total		
			Dollars			Dollars		Dollars	Dollars
Forage harvester									
Corn silage	2-row	3.28	--	3.28	4.10	1.54	5.64	3.28	5.64
Milo silage	2-row	3.28	--	3.28	4.10	1.54	5.64	2.30	3.95
Small grain silage	2-row	3.28	--	3.28	4.10	1.54	5.64	1.12	1.92
Cottonpicker									
first picking 1/	1-row	2.74	--	2.74	3.65	1.37	5.02	3.56	6.53
second picking 1/	1-row	2.74	--	2.74	3.65	1.37	5.02	2.74	5.02
Cottonpicker									
first picking	2-row	8.44	.97	9.41	11.25	4.22	15.47	7.81	12.84
second picking	2-row	8.44	.97	9.41	11.25	4.22	15.47	5.83	9.59
Combine - soybean	14 ft.	6.05	.80	6.85	7.56	2.27	9.83	2.26	3.24
Combine - rice	14 ft.	7.30	.80	8.10	9.12	2.74	11.86	7.70	11.27
Combine - corn	14 ft.	6.35	.80	7.15	7.94	2.38	10.32	3.58	5.16
Cotton trailer	6 bale	.37	--	.37	.46	.21	.67	--	--
Grain cart	--	.40	--	.40	.50	.22	.72	--	--
Land plane	40 x 10	.37	--	.37	.62	.47	1.09	--	--
Forage wagon	--	.82	--	.82	1.37	.77	2.14	--	--
Forage blower	--	.41	--	.41	.82	.03	.85	--	--

1/ Power unit and fixed costs per hour must be incorporated with machine direct and fixed costs to derive a cotton-picker direct and fixed cost per acre.

Table 3. Materials prices, Delta area of Mississippi, 1970.

Item	Unit	Cost
		Dollars
Seed:		
Cotton	ton	330.00
Soybeans	bu.	3.35
Wheat	bu.	2.90
Oats	bu.	1.50
Corn	bu.	13.92
Grain sorghum	cwt.	.25
Fertilizer:		
Anhydrous ammonia	lb. N	.0498
Ammonium nitrate	cwt.	2.87
0-20-20	cwt.	1.20
Urea (feed grade)	ton	55.00
Limestone (applied)	ton	8.00
Labor	hr.	1.50
Custom rates:		
Insecticide application	acre	.70
Defoliant application	acre	1.00
Herbicides:		
Treflan	gal.	23.50
Planavin	lb.	4.75
Karmex DL	gal.	14.50
Karmex WP	lb.	3.00
Cotoran	lb.	4.00
MSMA	gal.	3.00
Surfactants	gal.	2.25
Dynap	gal.	4.90
Dinitro	gal.	3.60
Lorox	lb.	2.85
Herban	lb.	3.00
Propazine	lb.	2.85
Atrazine	lb.	2.85
Insecticides:		
4-2-0.5	gal.	2.60
Methyl parathion	gal.	4.00
Bidrin	gal.	27.00
Aldrin	lb.	1.36
Di-Syston	lb.	0.25
Defoliants:		
Def	gal.	8.50
Folex	gal.	8.50

Table 4. Crop yields per acre on sand and clay soils, Delta area of Mississippi, 1966-68.

Crop	Unit	Average yield	Range
Cotton lint			
Sand			
Solid	lb.	730	700-850
2 x 1	lb.	960	925-1120
2 x 2	lb.	1050	950-1250
4 x 4	lb.	960	925-1050
Clay			
Solid	lb.	620	500-650
Cottonseed			
Sand			
Solid	cwt.	11.5	11.0-13.4
2 x 1	cwt.	15.1	14.5-17.6
2 x 2	cwt.	16.5	14.9-19.6
4 x 4	cwt.	15.1	14.5-16.5
Clay			
Solid	cwt.	9.7	7.9-10.2
Soybeans			
Sand	bu.	24	12-40
Clay	bu.	26	18-40
Wheat			
Sand	bu.	28	20-40
Clay	bu.	25	15-40
Oats			
Sand	bu.	65	50-110
Clay	bu.	50	40-100
Small grain silage	ton	5	3-6
Corn (irrigated)			
Sand			
for grain	bu.	90	80-150
for silage (high energy 40% dry matter)	ton	11	9-15
Grain sorghum			
Sand and clay			
for grain	lb.	3300	2500-5000
for silage (high energy 40% dry matter)	ton	5	4-7

tu production costs were included in an e lier publication.[3/]

Previous research has been reported ich indicated certain yield responses uld be expected when cotton was nted in other than a solid pattern.[4/] en, in analyzing various planting possi- ties, the variation in per acre produc- n costs among the various patterns is ored. The inclusion in this publication specified direct costs data for the vari- planting patterns should reduce the quency of these oversights.

Cotton – Sandy Soils

neral

Cotton production practices in the oo-Mississippi Delta included seedbed paration, planting, weed control, in- control, and harvesting. Seedbed paration usually began at the end of previous year's harvesting season and tinued up to the recommended plant- data. Deep tillage was done in the fall n possible. Most farmers intensified r seedbed preparation in February, ch, and early April, generally limited by the prevailing weather conditions soil type. Planting dates vary from north to south Delta, but generally nded from April 15 through May 15. arly weed control was generally ac- plished by preplant or preemergence icide applications. Early cultivations e without chemical weed control aids. ly season insect control was necessary many fields. As the cotton matured, ivation, postemergence applications appropriate chemicals, and limited d weed control measures were em- ed. Lay-by cultivation plus postemer- ce chemical application usually occur- in early July.

nsect control measures began in late July, intensified during August, and continued into early September.

Harvest began in late September and generally was concluded by the end of November. Pre-harvest defoliation was practiced by most producers. About 85% of the cotton in the Mississippi Delta was picked twice. Stalk cutting followed the final harvest.

Solid Planted

Solid planted cotton in the Delta area of Mississippi was planted on row centers of 38" or 40" in width. Budgets for solid planted cotton utilizing the various equipment combinations, soil types, technologies, and time sequence of field operations beginning with planting are included in Tables 5 through 8.

The use of 6-row equipment resulted in reductions of $1.75 to $2.80 per acre in total specified costs when compared to 4-row equipment. These savings were achieved principally by reductions in direct tractor operating expenses and fewer hours of labor input being required for each acre of production.

More efficient producers were able to obtain yields comparable to those of the usual producers with $13.01 to $14.06 less per acre in specified direct costs. These more efficient producers prepared their seedbeds with two fewer field operations, controlled weeds with two less field cultivations, and applied insecticides only

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3/ Spurgeon, W. I., and Fred T. Cooke, Jr., "Cost Reduction Research for Cotton Production Systems in the Yazoo-Mississippi Delta". Miss. Agri. Expt. Sta. Bul. 783, January 1971.

4/ Cooke, Jr., Fred T. and Arthur M. Heagler, "An Economic Appraisal of Skip-Row Cotton Planting in the Yazoo-Mississippi Delta." Miss. Agri. Expt. Sta. Bul. 697, November 1964.

Table 5. Cotton production costs per acre on sandy soils, 4-row equipment, solid planted, and usual farm practices, Delta area of Mississip

Operation	Tractor costs		Equipment costs		Labor costs	Materia costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollar
Row condition	.37	.24	.14	.29	.36	--
Plant & preemerge	.37	.24	.21	.44	.72	5.63
Tractor & trailer	.10	.12	.06	.13	.40	--
Cultivate	.39	.25	.08	.14	.38	--
Poison thrips	--	--	.18	.21	.15	.34
Cultivate & postemerge	.43	.27	.11	.19	.42	.43
Cultivate & postemerge	.43	.27	.11	.19	.42	2.43
Hand weed control	--	--	--	--	5.25	--
Cultivate & postemerge	.37	.24	.09	.17	.36	1.93
Cultivate & postemerge	.37	.24	.09	.17	.36	2.43
Cultivate	.31	.20	.06	.11	.30	
Cultivate & postemerge	.37	.24	.09	.17	.36	2.90
Hand weed control	--	--	--	--	3.75	--
Poison x 5 (ground)	--	--	.90	1.05	.75	6.50
Poison x 4 (custom air)	--	--	2.80	--	.16	5.20
Defoliate	--	--	.18	.21	.15	2.12
Harvest	--	--	7.81	12.84	2.50	--
Haul	.60	.72	.30	.78	.75	--
Harvest	--	--	4.96	8.15	1.58	--
Haul	.15	.18	.08	.19	.19	--
Cut stalks	.47	.29	.03	.09	.45	--
Subsoil	1.01	.64	.18	.27	.98	--
Chisel	.47	.29	.08	.17	.45	--
Chisel	.47	.29	.08	.17	.45	--
Disk	.36	.23	.17	.29	.35	--
Disk	.36	.23	.17	.29	.35	--
Bed	.31	.20	.10	.16	.30	--
Rebed & fertilize	.36	.23	.20	.33	.35	4.74
Totals	8.07	5.61	19.26	27.20	22.99	34.65
Total costs excluding ginning			$117.78			

Table 6. Cotton production costs per acre on sandy soil, 4-row equipment, solid planted, and more efficient practices, Delta area of Mississippi.

Operation	Tractor costs		Equipment costs		Labor costs	Materials costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Re condition	.37	.24	.14	.29	.36	--
Pnt & preemerge	.37	.24	.21	.44	.72	4.85
Tctor & trailer	.10	.12	.06	.13	.40	--
Ctivate	.39	.25	.08	.14	.38	--
Pson thrips	--	--	.18	.21	.15	.34
Ctivate & postemerge	.43	.27	.11	.19	.42	.43
Ctivate & postemerge	.43	.27	.11	.19	.42	2.43
Hd weed control	--	--	--	--	5.25	--
Ctivate & postemerge	.37	.24	.09	.17	.36	1.93
Ctivate & postemerge	.37	.24	.09	.17	.36	.81
Hd weed control	--	--	--	--	3.75	--
Pson x 5 (ground)	--	--	.90	1.05	.75	6.50
Pson x 2 (custom air)	--	--	1.40	--	.08	2.60
Doliate	--	--	.18	.21	.15	2.12
Hvest	--	--	7.81	12.84	2.50	--
Ll	.60	.72	.30	.78	.75	--
Hvest	--	--	4.96	8.15	1.58	--
Ll	.15	.18	.08	.19	.19	--
S stalks	.47	.29	.03	.09	.45	--
soil	1.01	.64	.18	.27	.98	--
sel	.47	.29	.08	.17	.45	--
sel	.47	.29	.08	.17	.45	--
k	.36	.23	.17	.29	.35	--
& fertilize	.36	.23	.20	.33	.35	4.74
otals	6.72	4.74	17.44	26.47	21.60	26.75
otal costs excluding ginning			$103.72			

Table 7. Cotton production costs per acre on sandy soils, 6-row equipment, solid planted, and usual farm practices, Delta area of Mississipp

Operation	Tractor costs		Equipment costs		Labor costs	Materi.s cost
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dolla
Row condition	0.28	0.18	0.17	0.36	0.27	--
Plant & preemerge	.28	.18	.21	.43	.54	5.6
Tractor & trailer	.10	.12	.06	.13	.40	--
Cultivate	.33	.21	.10	.18	.32	--
Poison thrips	--	--	.18	.21	.15	.3
Cultivate & postemerge	.37	.24	.14	.25	.36	.4
Cultivate & postemerge	.37	.24	.14	.25	.36	2.4
Hand weed control	--	--	--	--	5.25	--
Cultivate & postemerge	.28	.18	.10	.19	.27	1.9
Cultivate & postemerge	.28	.18	.10	.19	.27	2.4
Cultivate	.22	.14	.07	.12	.21	--
Cultivate & postemerge	.28	.18	.10	.19	.27	2.9
Hand weed control	--	--	--	--	3.75	--
Poison x 5 (ground)	--	--	.90	1.05	.75	6.5
Poison x 4 (custom air)	--	--	2.80	--	.16	5.2
Defoliate	--	--	.18	.21	.15	2.1
Harvest	--	--	7.81	12.84	2.50	--
Haul	.60	.72	.30	.78	.75	--
Harvest	--	--	4.96	8.15	1.58	--
Haul	.15	.18	.08	.19	.19	--
Cut stalks	.47	.29	.03	.09	.45	--
Subsoil	1.01	.64	.18	.27	.98	--
Chisel	.47	.29	.08	.17	.45	--
Chisel	.47	.29	.08	.17	.45	--
Disk	.22	.14	.17	.29	.21	--
Disk	.22	.14	.17	.29	.21	--
Bed	.20	.13	.11	.18	.20	--
Rebed & fertilize	.25	.16	.21	.35	.24	4.7
Totals	6.85	4.83	19.43	27.53	21.69	34.6
Total costs excluding ginning			$114.98			

Table 8. Cotton production costs per acre on sandy soil, 6-row equipment, solid planted, and more efficient practices, Delta area of Mississippi.

Operation	Tractor costs		Equipment costs		Labor costs	Materials costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Bed condition	.28	.18	.17	.36	.27	--
Plant & preemerge	.28	.18	.21	.43	.54	4.85
Tractor & trailer	.10	.12	.06	.13	.40	--
Cultivate	.33	.21	.10	.18	.32	--
Poison thrips	--	--	.18	.21	.15	.34
Cultivate & postemerge	.37	.24	.14	.25	.36	.43
Cultivate & postemerge	.37	.24	.14	.25	.36	2.43
Hand weed control	--	--	--	--	5.25	--
Cultivate & postemerge	.28	.18	.10	.19	.27	1.93
Cultivate & postemerge	.28	.18	.10	.19	.27	.81
Hand weed control	--	--	--	--	3.75	--
Poison x 5 (ground)	--	--	.90	1.05	.75	6.50
Poison x 2 (custom air)	--	--	1.40	--	.08	2.60
Defoliate	--	--	.18	.21	.15	2.12
Harvest	--	--	7.81	12.84	2.50	--
Haul	.60	.72	.30	.78	.75	--
Harvest	--	--	4.96	8.15	1.58	--
Haul	.15	.18	.08	.19	.19	--
Shred stalks	.47	.29	.03	.09	.45	--
Disk soil	1.01	.64	.18	.27	.98	--
Fertilize	.47	.29	.08	.17	.45	--
Fertilize	.47	.29	.08	.17	.45	--
Bedding	.22	.14	.17	.29	.21	--
Seed & fertilize	.25	.16	.21	.35	.24	4.74
Totals	5.93	4.24	17.58	26.75	20.72	26.75
Total costs excluding ginning			$101.97			

8 times rather than the usual 10 applications.

The relatively new set of seedbed preparation practices outlined in Table 9 and 10 has been recommended for "sandy" soils as identified in this publication.[5/] The recommendation does not include using this technology when a heavy infestation of any perennial grass is present. When compared to the practices outlined for the efficient producers, using 6-row equipment in Table 8, this technology eliminates three field operations in the seedbed preparation process with a resulting savings of $3.20. In some cases it is possible that a rebedding will be necessary, in which case the saving for the more efficient producer is $2.38 per acre. An added advantage of this method of seedbed preparation is that a consistent 5% or greater yield increase has been observed when compared to the usual seedbed preparation methods shown in Table 7.[6/] Also, significantly less tractor and labor inputs are required during the spring peak labor requirement period.

Skip-Row

Yield responses to various skip-row planting patterns have been reported.[7/] As shown in Tables 11 through 22, skip-row patterns resulted in increased expenses in direct and fixed tractor costs, direct and fixed equipment costs, labor costs, and materials costs. Greater weed control expenditures, reduced efficiency in broadcast insecticide applications, and increased seedbed preparation costs were the primary contributors to increased expenditures.

Cotton - Clay Soils

Budgets for solid planted cotton grown on clay soils are included in Tables 23-26. Skip-row patterns were infrequently utilized on these soil types in the delta area of Mississippi. Primary differential in production practices were equipment size and time of seedbed preparation either fall or spring.

Compared to solid planted cotton on sandy soils, less deep tillage was required for clay soils. However, greater expenditures were necessary for chemical weed control due to higher per acre rates required for a given level of control. Generally larger quantities of nitrogen fertilizer were applied to the clay soils.

More field operations were utilized for spring seedbed preparation than for fall preparation, hence, greater tractor, equipment, and labor costs were incurred. However, unless cotton followed an early maturing soybean variety grown the previous crop season, days available for field work on clay soil types were a seldom restricting factor in utilizing fall seedbed preparation procedures.

Soybeans - Sandy Soils

Soybeans were normally planted from May 10 to June 15 in the Delta area of Mississippi. Varieties have been developed to permit some variability in both planting dates and harvesting dates. This crop is adapted to a wide range of soil type

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5/ Spurgeon, W. I. and Fred T. Cooke, Jr. "Cost Reduction Research for Cotton Production Systems in the Yazoo-Mississippi Delta." Miss. Agri. Expt. Sta. Bul. 783, January 19

6/ Ibid.

7/ Cooke, Jr., Fred T. and Arthur M. Heagler, "An Economic Appraisal of Skip-Row Cotton Planting in the Yazoo-Mississippi Delta." Miss. Agri. Expt. Sta. Bul. 697, November 1964.

le 9. Cotton production costs per acre on sandy soil, 6-row equipment, stubble planted, and more efficient practices, Delta area of Mississippi.

ration	Tractor costs		Equipment costs		Labor costs	Materials costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
condition	.28	.18	.17	.36	.27	--
nt & preemerge	.28	.18	.21	.43	.54	4.85
ctor & trailer	.10	.12	.06	.13	.40	--
tivate	.33	.21	.10	.18	.32	--
son thrips	--	--	.18	.21	.15	.34
tivate & postemerge	.37	.24	.14	.25	.36	.43
tivate & postemerge	.37	.24	.14	.25	.36	2.43
d weed control	--	--	--	--	6.00	--
tivate & postemerge	.28	.18	.10	.19	.27	1.93
tivate & postemerge	.28	.18	.10	.19	.27	.81
d weed control	--	--	--	--	3.75	--
son x 5 (ground)	--	--	.90	1.05	.75	6.50
son x 2 (custom air)	--	--	1.40	--	.08	2.60
oliate	--	--	.18	.21	.15	2.12
vest	--	--	7.81	12.84	2.50	--
l	.60	.72	.30	.78	.75	--
vest	--	--	4.96	8.15	1.58	--
l	.15	.18	.08	.19	.19	--
stalks	.47	.29	.03	.09	.45	--
soil	1.01	.64	.18	.27	.98	--
& fertilize	.25	.16	.21	.35	.24	4.74
otals	4.77	3.52	17.25	26.12	20.36	26.75
otal costs excluding ginning			$98.77			

Table 10. Cotton production costs per acre on sandy soil, 4-row equipment, stubble planted, and more efficient practices, Delta area of Mississippi.

Operation	Tractor costs		Equipment costs		Labor costs	Materials cos
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Row condition	.37	.24	.14	.29	.36	--
Plant & preemerge	.37	.24	.21	.44	.72	4.8
Tractor & trailer	.10	.12	.06	.13	.40	--
Cultivate	.39	.25	.08	.14	.38	--
Poison thrips	--	--	.18	.21	.15	.3
Cultivate & postemerge	.43	.27	.11	.19	.42	.4
Cultivate & postemerge	.43	.27	.11	.19	.42	2.4
Hand weed control	--	--	--	--	6.00	--
Cultivate & postemerge	.37	.24	.09	.17	.36	1.9
Cultivate & postemerge	.37	.24	.09	.17	.36	.8
Hand weed control	--	--	--	--	3.75	--
Poison x 5 (ground)	--	--	.90	1.05	.75	6.5
Poison x 2 (custom air)	--	--	1.40	--	.08	2.6
Defoliate	--	--	.18	.21	.15	2.1
Harvest	--	--	7.81	12.84	2.50	--
Haul	.60	.72	.30	.78	.75	--
Harvest	--	--				--
Haul	.15	.18	.08	.19	.19	--
Cut stalks	.47	.29	.03	.09	.45	--
Subsoil	1.01	.64	.18	.27	.98	--
Bed & fertilize	.36	.23	.20	.33	.35	4.7
Totals	5.42	3.93	17.11	25.84	21.10	26.7
Total costs excluding ginning			$100.15			

Table 11. Cotton production costs per acre on sandy soil, 4-row equipment, 2 x 1, and usual farm practices, Delta area of Mississippi.

ration	Tractor costs		Equipment costs		Labor costs	Materials costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
condition	.50	.31	.19	.38	.48	--
t & preemerge	.50	.31	.28	.59	.96	5.63
ctor & trailer	.10	.12	.06	.13	.40	--
tivate	.78	.49	.15	.27	.75	--
son thrips	--	--	.18	.21	.15	.34
tivate & postemerge	.87	.55	.21	.39	.84	.43
tivate & postemerge	.87	.55	.21	.39	.84	2.43
d weed control	--	--	--	--	5.25	--
tivate & postemerge	.74	.47	.18	.33	.72	1.93
tivate & postemerge	.74	.47	.18	.33	.72	2.43
tivate	.62	.39	.12	.22	.60	--
tivate & postemerge	.74	.47	.18	.33	.72	2.90
d weed control	--	--	--	--	3.75	--
son x 6 (ground)	--	--	1.08	1.26	.90	7.80
son x 3 (custom air)	--	--	3.15	--	.18	5.85
oliate	--	--	.18	.21	.15	2.12
vest	--	--	7.81	12.84	2.50	--
l	.79	.95	.40	1.03	.99	--
vest	--	--	4.96	8.15	1.58	--
l	.20	.24	.11	.25	.25	--
stalks	.47	.29	.03	.09	.45	--
soil	1.01	.64	.18	.27	.98	--
sel	.70	.44	.13	.26	.68	--
sel	.70	.44	.13	.26	.68	--
k	.54	.34	.26	.44	.53	--
k	.54	.34	.26	.44	.53	--
	.47	.29	.15	.25	.45	--
ed & fertilize	.54	.34	.31	.50	.53	4.74
otals	12.42	8.44	21.08	29.82	27.56	36.60
otal costs excluding ginning			$135.92			

Table 12. Cotton production costs per acre on sandy soil, 4-row equipment, 2 x 1, and more efficient practices, Delta area of Mississippi.

Operation	Tractor costs		Equipment costs		Labor costs	Materia costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollar
Row condition	.50	.31	.19	.38	.48	--
Plant & preemerge	.50	.31	.28	.59	.96	4.85
Tractor & trailer	.10	.12	.06	.13	.40	--
Cultivate	.78	.49	.15	.27	.75	--
Poison thrips	--	--	.18	.21	.15	.34
Cultivate & postemerge	.87	.55	.21	.39	.84	.43
Cultivate & postemerge	.87	.55	.21	.39	.84	2.43
Hand weed control	--	--	--	--	5.25	--
Cultivate & postemerge	.74	.47	.18	.33	.72	1.93
Cultivate & postemerge	.74	.47	.18	.33	.72	.81
Hand weed control	--	--	--	--	3.75	--
Poison x 5 (ground)	--	--	.90	1.05	.75	6.50
Poison x 2 (custom air)	--	--	2.10	--	.12	3.90
Defoliate	--	--	.18	.21	.15	2.12
Harvest	--	--	7.81	12.84	2.50	--
Haul	.79	.95	.40	1.03	.99	--
Harvest	--	--	4.96	8.15	1.58	--
Haul	.20	.24	.11	.25	.25	--
Cut stalks	.47	.29	.03	.09	.45	--
Subsoil	1.01	.64	.18	.27	.98	--
Chisel	.70	.44	.13	.26	.68	--
Chisel	.70	.44	.13	.26	.68	--
Disk	.54	.34	.26	.44	.53	--
Bed & fertilize	.54	.34	.31	.50	.53	4.74
Totals	10.05	6.95	19.14	28.37	25.05	28.05
Total costs excluding ginning		$117.61				

e 13. Cotton production costs per acre on sandy soil, 4-row equipment, 2 x 2, and usual farm practices, Delta area of Mississippi.

ation	Tractor costs		Equipment costs		Labor costs	Materials costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
condition	.50	.31	.19	.38	.48	--
t & preemerge	.50	.31	.28	.59	.96	5.63
tor & trailer	.10	.12	.06	.13	.40	--
ivate	.78	.49	.15	.27	.75	--
on thrips	--	--	.18	.21	.15	.34
ivate & postemerge	.87	.55	.21	.39	.84	.43
ivate & postemerge	.87	.55	.21	.39	.84	2.43
ivate skips	.54	.34	.07	.13	.53	--
weed control	--	--	--	--	5.25	--
ivate & postemerge	.74	.47	.18	.33	.72	1.93
ivate skips	.54	.34	.07	.13	.53	--
ivate & postemerge	.74	.47	.18	.33	.72	2.43
ivate	.62	.39	.12	.22	.60	--
ivate & postemerge	.74	.47	.18	.33	.72	2.90
weed control	--	--	--	--	3.75	--
on x 6 (ground)	--	--	1.08	1.26	.90	7.80
on x 3 (custom air)	--	--	4.20	--	.24	7.80
ivate skips	.54	.34	.07	.13	.53	--
ivate skips	.54	.34	.07	.13	.53	--
liate	--	--	.18	.21	.15	2.12
est	--	--	7.81	12.84	2.50	--
	.86	1.04	.43	1.12	1.08	--
est	--	--	4.96	8.15	1.58	--
	.22	.26	.12	.27	.27	--
stalks	.47	.29	.03	.09	.45	--
oil	1.01	.64	.18	.27	.98	--
el	.93	.59	.17	.35	.90	--
el	.93	.59	.17	.35	.90	--
	.71	.45	.34	.58	.69	--
	.71	.45	.34	.58	.69	--
	.62	.39	.20	.33	.60	--
d & fertilize	.71	.45	.40	.66	.69	4.74
tals	15.79	10.64	22.83	31.15	30.92	38.55

tal costs excluding ginning $149.88

Table 14. Cotton production costs per acre on sandy soil, 4-row equipment, 2 x 2, and more efficient practices, Delta area of Mississippi.

Operation	Tractor costs		Equipment costs		Labor costs	Materials cost
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Row condition	.50	.31	.19	.38	.48	--
Plant & preemerge	.50	.31	.28	.59	.96	4.85
Tractor & trailer	.10	.12	.06	.13	.40	--
Cultivate	.78	.49	.15	.27	.75	--
Poison thrips	--	--	.18	.21	.15	.34
Cultivate & postemerge	.87	.55	.21	.39	.84	.43
Cultivate & postemerge	.87	.55	.21	.39	.84	2.43
Cultivate skips	.54	.34	.07	.13	.53	--
Hand weed control	--	--	--	--	5.25	--
Cultivate & postemerge	.74	.47	.18	.33	.72	1.93
Cultivate & postemerge	.74	.47	.18	.33	.72	.81
Cultivate skips	.54	.34	.07	.13	.53	--
Hand weed control	--	--	--	--	3.75	--
Poison x 3 (ground)	--	--	.90	1.05	.75	6.50
Poison x 2 (custom air)	--	--	2.80	--	.16	5.20
Defoliate	--	--	.18	.21	.15	2.12
Harvest	--	--	7.81	12.84	2.50	--
Haul	.86	1.04	.43	1.12	1.08	--
Harvest	--	--	4.96	8.15	1.58	--
Haul	.22	.26	.12	.27	.27	--
Cut stalks	.47	.29	.03	.09	.45	--
Subsoil	1.01	.64	.18	.27	.98	--
Chisel	.93	.59	.17	.35	.90	--
Chisel	.93	.59	.17	.35	.90	--
Disk	.71	.45	.34	.58	.69	--
Bed & fertilize	.71	.45	.40	.66	.69	4.74
Totals	12.02	8.26	20.27	29.22	27.02	29.35
Total costs excluding ginning			$126.14			

Table 15. Cotton production costs per acre on sandy soil, 4-row equipment, 4 x 4, and usual farm practices, Delta area of Mississippi.

Operation	Tractor costs		Equipment costs		Labor costs	Materials costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
c condition	.37	.24	.14	.29	.36	--
lt & preemerge	.37	.24	.21	.44	.72	5.63
r:tor & trailer	.10	.12	.06	.13	.40	--
u.ivate	.39	.25	.08	.14	.38	--
o:on thrips	--	--	.18	.21	.15	.34
u.ivate & postemerge	.43	.27	.11	.19	.42	.43
u.ivate & postemerge	.43	.27	.11	.19	.42	2.43
u:ivate skips	.31	.20	.06	.11	.30	--
al weed control	--	--	--	--	5.25	--
u ivate & postemerge	.37	.24	.09	.17	.36	1.93
u ivate skips	.31	.20	.06	.11	.30	--
u ivate & postemerge	.37	.24	.09	.17	.36	2.43
u ivate	.31	.20	.06	.11	.30	--
u ivate skips	.31	.20	.06	.11	.30	--
u ivate & postemerge	.37	.24	.09	.17	.36	2.90
a weed control	--	--	--	--	3.75	--
on x 6 (ground)	--	--	1.08	1.26	.90	7.80
on x 3 (custom air)	--	--	4.20	--	.24	7.80
i skips	.36	.23	.17	.29	.35	--
i skips	.36	.23	.17	.29	.35	--
e liate	--	--	.18	.21	.15	2.12
est	--	--	7.81	12.84	2.50	--
	.79	.95	.40	1.03	.99	--
est	--	--	4.96	8.15	1.58	--
	.20	.24	.11	.25	.25	--
stalks	.47	.29	.03	.09	.45	--
oil	1.01	.64	.18	.27	.98	--
el	.47	.29	.08	.17	.45	--
el	.93	.59	.17	.35	.90	--
	.71	.45	.34	.58	.69	--
	.36	.23	.17	.29	.35	--
	.31	.20	.10	.16	.30	--
d & fertilize	.36	.23	.20	.33	.35	4.74
tals	10.77	7.48	21.75	29.10	25.91	38.55
tal costs excluding ginning			$133.56			

Table 16. Cotton production costs per acre on sandy soil, 4-row equipment, 4 x 4, and more efficient practices, Delta area of Mississippi.

Operation	Tractor costs		Equipment costs		Labor costs	Materials costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollar
Row condition	.37	.24	.14	.29	.36	--
Plant & preemerge	.37	.24	.21	.44	.72	4.85
Tractor & trailer	.10	.12	.06	.13	.40	--
Cultivate	.39	.25	.08	.14	.38	--
Poison thrips	--	--	.18	.21	.15	.34
Cultivate skips	.31	.20	.06	.11	.30	--
Cultivate & postemerge	.43	.27	.11	.19	.42	.43
Cultivate & postemerge	.43	.27	.11	.19	.42	2.43
Cultivate skips	.31	.20	.06	.11	.30	--
Hand weed control	--	--	--	--	5.25	--
Cultivate & postemerge	.37	.24	.09	.17	.36	1.93
Cultivate & postemerge	.37	.24	.09	.17	.36	.81
Cultivate skips	.31	.20	.06	.11	.30	--
Hand weed control	--	--	--	--	3.75	--
Poison x 5 (ground)	--	--	.90	1.05	.75	6.50
Poison x 2 (custom air)	--	--	2.80	--	.16	5.20
Defoliate	--	--	.18	.21	.15	2.12
Harvest	--	--	7.81	12.84	2.50	--
Haul	.79	.95	.40	1.03	.99	--
Harvest	--	--	4.96	8.15	1.58	--
Haul	.20	.24	.11	.25	.25	--
Cut stalks	.47	.29	.03	.09	.45	--
Subsoil	1.01	.64	.18	.27	.98	--
Chisel	.47	.29	.08	.17	.45	--
Chisel	.93	.59	.17	.35	.90	--
Disk	.71	.45	.34	.58	.69	--
Bed & fertilize	.36	.23	.20	.33	.35	4.74
Totals	8.70	6.15	19.14	27.58	23.67	29.35
Total costs excluding ginning			$114.86			

a e 17. Cotton production costs per acre on sandy soil, 6-row equipment, 2 x 1, and usual farm practices, Delta area of Mississippi.

p ation	Tractor costs		Equipment costs		Labor costs	Materials costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
o condition	.37	.24	.23	.48	.36	--
lit & preemerge	.37	.24	.28	.58	.72	5.63
r tor & trailer	.10	.12	.06	.13	.40	--
u ivate	.47	.29	.14	.26	.45	--
o on thrips	--	--	.18	.21	.15	.34
u ivate & postemerge	.56	.35	.21	.37	.54	.43
u ivate & postemerge	.56	.35	.21	.37	.54	2.43
al weed control	--	--	--	--	5.25	--
u ivate & postemerge	.42	.26	.16	.28	.41	1.93
u ivate & postemerge	.42	.26	.16	.28	.41	2.43
u ivate	.33	.21	.10	.18	.32	--
u ivate & postemerge	.42	.26	.16	.28	.41	2.90
al weed control	--	--	--	--	3.75	--
o on x 6 (ground)	--	--	1.08	1.26	.90	7.80
o on x 3 (custom air)	--	--	3.15	--	.18	5.85
e liate	--	--	.18	.21	.15	2.12
a est	--	--	7.81	12.84	2.50	--
a	.79	.95	.40	1.03	.99	--
a est	--	--	4.96	8.15	1.58	--
a	.20	.24	.11	.25	.25	--
u stalks	.47	.29	.03	.09	.45	--
t soil	1.01	.64	.18	.27	.98	--
h el	.70	.44	.13	.26	.68	--
h el	.70	.44	.13	.26	.68	--
i	.33	.21	.25	.43	.32	--
d	.33	.21	.25	.43	.32	--
e	.31	.20	.17	.28	.30	--
ed & fertilize	.33	.21	.18	.30	.32	4.74
tals	9.19	6.41	20.90	29.48	24.31	36.60
tal costs excluding ginning			$126.89			

Table 18. Cotton production costs per acre on sandy soil, 6-row equipment, 2 x 1, and more efficient practices, Delta area of Mississippi.

Operation	Tractor costs		Equipment costs		Labor costs	Materia costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollar
Row condition	.37	.24	.23	.48	.36	--
Plant & preemerge	.37	.24	.28	.58	.72	4.85
Tractor & trailer	.10	.12	.06	.13	.40	--
Cultivate	.47	.29	.14	.26	.45	--
Poison thrips	--	--	.18	.21	.15	.34
Cultivate & postemerge	.56	.35	.21	.37	.54	.43
Cultivate & postemerge	.56	.35	.21	.37	.54	2.43
Hand weed control	--	--	--	--	5.25	--
Cultivate & postemerge	.42	.26	.16	.28	.41	1.93
Cultivate & postemerge	.42	.26	.16	.28	.41	.81
Hand weed control	--	--	--	--	3.75	--
Poison x 5 (ground)	--	--	.90	1.05	.75	6.50
Poison x 2 (custom air)	--	--	2.10	--	.12	3.90
Defoliate	--	--	.18	.21	.15	2.12
Harvest	--	--	7.81	12.84	2.50	--
Haul	.79	.95	.40	1.03	.99	--
Harvest	--	--	4.96	8.15	1.58	--
Haul	.20	.24	.11	.25	.25	--
Cut stalks	.47	.29	.03	.09	.45	--
Subsoil	1.01	.64	.18	.27	.98	--
Chisel	.70	.44	.13	.26	.68	--
Chisel	.70	.44	.13	.26	.68	--
Disk	.33	.21	.25	.43	.32	--
Bed & fertilize	.37	.24	.32	.52	.36	4.74
Totals	7.84	5.56	19.13	28.32	22.79	28.05
Total costs excluding ginning			$111.69			

Table 19. Cotton production costs per acre on sandy soil, 6-row equipment, 2 x 2, and usual farm practices, Delta area of Mississippi.

Operation	Tractor costs		Equipment costs		Labor costs	Materials costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
K condition	.37	.24	.23	.48	.36	--
Pnt & preemerge	.37	.24	.28	.58	.72	5.63
Tctor & trailer	.10	.12	.06	.13	.40	--
Ctivate	.50	.31	.15	.27	.48	--
Pson thrips	--	--	.18	.21	.15	.34
Ctivate & postemerge	.56	.35	.21	.37	.54	.43
Ctivate & postemerge	.56	.35	.21	.37	.54	2.43
Ctivate skips	.54	.34	.07	.13	.53	--
Hd weed control	--	--	--	--	5.25	--
Ctivate & postemerge	.42	.26	.16	.28	.41	1.93
Ctivate skips	.54	.34	.07	.13	.53	--
Ctivate & postemerge	.42	.26	.16	.28	.41	2.43
Ctivate	.33	.21	.10	.18	.32	--
Ctivate & postemerge	.42	.26	.16	.28	.41	2.90
Hd weed control	--	--	--	--	3.75	--
Pson x 6 (ground)	--	--	1.08	1.26	.75	7.80
Pson x 3 (custom air)	--	--	4.20	--	.24	7.80
Ctivate skips	.54	.34	.07	.13	.53	--
Ctivate skips	.54	.34	.07	.13	.53	--
Doliate	--	--	.18	.21	.15	2.12
Avest	--	--	7.81	12.84	2.50	--
Al	.86	1.04	.43	1.12	1.08	--
Avest	--	--	4.96	8.15	1.58	--
Al	.22	.26	.12	.27	.27	--
S stalks	.47	.29	.03	.09	.45	--
Dsoil	1.01	.64	.18	.27	.98	--
Dsel	.93	.59	.17	.35	.90	--
Dsel	.93	.59	.17	.35	.90	--
Dk	.43	.27	.33	.57	.42	--
Dk	.43	.27	.33	.57	.42	--
S	.40	.25	.23	.37	.39	--
Aed & fertilize	.50	.31	.43	.70	.48	4.74
Totals	12.39	8.47	22.83	31.07	27.37	38.55
Total costs excluding ginning			$140.68			

Table 20. Cotton production costs per acre on sandy soil, 6-row equipment, 2 x 2, and more efficient practices, Delta area of Mississippi.

Operation	Tractor costs		Equipment costs		Labor costs	Material costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Row condition	.37	.24	.23	.48	.36	--
Plant & preemerge	.37	.24	.28	.58	.72	4.85
Tractor & trailer	.10	.12	.06	.13	.40	--
Cultivate	.50	.31	.15	.27	.48	--
Poison thrips	--	--	.18	.21	.15	.34
Cultivate & postemerge	.56	.35	.21	.37	.54	.43
Cultivate & postemerge	.56	.35	.21	.37	.54	2.43
Cultivate skips	.54	.34	.07	.13	.53	--
Hand weed control	--	--	--	--	5.25	--
Cultivate & postemerge	.42	.26	.16	.28	.41	1.93
Cultivate & postemerge	.42	.26	.16	.28	.41	.81
Cultivate skips	.54	.34	.07	.13	.53	--
Hand weed control	--	--	--	--	3.75	--
Poison x 5 (ground)	--	--	.90	1.05	.75	6.50
Poison x 2 (custom air)	--	--	2.80	--	.16	5.20
Cultivate skips	.54	.34	.07	.13	.53	--
Defoliate	--	--	.18	.21	.15	2.12
Harvest	--	--	7.81	12.84	2.50	--
Haul	.86	1.04	.43	1.12	1.08	--
Harvest	--	--	4.96	8.15	1.58	--
Haul	.22	.26	.12	.27	.27	--
Cut stalks	.47	.29	.03	.09	.45	--
Subsoil	1.01	.64	.18	.27	.98	--
Chisel	.93	.59	.17	.35	.90	--
Chisel	.93	.59	.17	.35	.90	--
Disk	.43	.27	.33	.57	.42	--
Disk	.43	.27	.33	.57	.42	--
Bed	.40	.25	.23	.37	.39	--
Rebed & fertilize	.50	.31	.43	.70	.48	4.74
Totals	11.10	7.66	20.92	30.27	26.03	29.35
Total costs excluding ginning			$125.33			

ble 21. Cotton production costs per acre on sandy soil, 6-row equipment, 4 x 4, and usual farm practices, Delta area of Mississippi.

Operation	Tractor costs		Equipment costs		Labor costs	Materials costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Re condition	.37	.24	.23	.48	.36	--
Plant & preemerge	.37	.24	.28	.58	.72	5.63
Tractor & trailer	.10	.12	.06	.13	.40	--
Cultivate	.39	.25	.12	.22	.38	--
Poison thrips	--	--	.18	.21	.15	.34
Cultivate & postemerge	.43	.27	.16	.29	.42	.43
Cultivate & postemerge	.43	.27	.16	.29	.42	2.43
Cultivate skips	.31	.20	.06	.11	.30	--
Hand weed control	--	--	--	--	5.25	--
Cultivate & postemerge	.37	.24	.14	.25	.36	1.93
Cultivate skips	.31	.20	.06	.11	.30	--
Cultivate & postemerge	.37	.24	.14	.25	.36	2.43
Cultivate	.31	.20	.09	.17	.30	--
Cultivate skips	.31	.20	.06	.11	.30	--
Cultivate & postemerge	.37	.24	.14	.25	.36	2.90
Hand weed control	--	--	--	--	3.75	--
Poison x 6 (ground)	--	--	1.08	1.26	.90	7.80
Poison x 3 (custom air)	--	--	4.20	--	.24	7.80
Disk skips	.36	.23	.17	.29	.35	--
Defoliate	--	--	.18	.21	.15	2.12
Harvest	--	--	7.81	12.84	2.50	--
Haul	.79	.95	.40	1.03	.99	--
Harvest	--	--	4.96	8.15	1.58	--
Haul	.20	.24	.11	.25	.25	--
Shred stalks	.47	.29	.03	.09	.45	--
Chisel	1.01	.64	.18	.27	.98	--
Diesel	.47	.29	.08	.17	.45	--
Diesel	.93	.59	.17	.35	.90	--
Disk	.43	.27	.33	.58	.42	--
Disk	.22	.14	.17	.29	.21	--
Bed	.31	.20	.17	.28	.30	--
Seed & fertilize	.36	.23	.31	.50	.35	4.74
Totals	9.99	6.98	22.23	30.01	25.15	38.55

Total costs excluding ginning $132.91

Table 22. Cotton production costs per acre on sandy soil, 6-row equipment, 4 x 4, and more efficient practices, Delta area of Mississippi.

Operation	Tractor costs		Equipment costs		Labor costs	Materia costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollar
Row condition	.37	.24	.23	.48	.36	--
Plant & preemerge	.37	.24	.28	.58	.72	4.85
Tractor & trailer	.10	.12	.06	.13	.40	--
Cultivate	.39	.25	.12	.22	.38	--
Poison thrips	--	--	.18	.21	.15	.34
Cultivate skips	.31	.20	.06	.11	.30	--
Cultivate & postemerge	.43	.27	.16	.29	.42	.43
Cultivate & postemerge	.43	.27	.16	.29	.42	2.43
Hand weed control	--	--	--	--	5.25	--
Cultivate & postemerge	.37	.24	.14	.25	.36	1.93
Cultivate & postemerge	.37	.24	.14	.25	.36	.81
Cultivate skips	.31	.20	.06	.11	.30	--
Hand weed control	--	--	--	--	3.75	--
Disk skips	.36	.23	.17	.29	.35	--
Poison x 5 (ground)	--	--	.90	1.05	.75	6.50
Poison x 2 (custom air)	--	--	2.80	--	.16	5.20
Defoliate	--	--	.18	.21	.15	2.12
Harvest	--	--	7.81	12.84	2.50	--
Haul	.79	.95	.40	1.03	.99	--
Harvest	--	--	4.96	8.15	1.58	--
Haul	.20	.24	.11	.25	.25	--
Cut stalks	.47	.29	.03	.09	.45	--
Subsoil	1.01	.64	.18	.27	.98	--
Chisel	.47	.29	.08	.17	.45	--
Chisel	.93	.59	.17	.35	.90	--
Disk	.43	.27	.33	.58	.42	--
Rebed & fertilize	.36	.23	.31	.50	.35	4.74
Totals	8.47	6.00	20.02	28.70	23.45	29.35
Total costs excluding ginning			$115.99			

ble 23. Cotton production costs per acre on clay soil, 4-row equipment, solid planted, spring seedbed preparation, and usual farm practices, Delta area of Mississippi.

Operation	Tractor costs		Equipment costs		Labor costs	Materials costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Rod condition	.37	.24	.14	.29	.36	--
Plant	.37	.24	.21	.44	.72	4.95
Tractor & trailer	.10	.12	.06	.13	.40	--
Cultivate	.39	.25	.08	.14	.38	--
Fertilize	.43	.27	.10	.20	.42	11.48
Poison thrips	--	--	.18	.21	.15	.34
Cultivate & postemerge	.43	.27	.11	.19	.42	.43
Cultivate & postemerge	.43	.27	.11	.19	.42	2.43
Hand weed control	--	--	--	--	5.25	--
Cultivate & postemerge	.37	.24	.09	.17	.36	1.93
Cultivate & postemerge	.37	.24	.09	.17	.36	2.43
Cultivate	.31	.20	.06	.11	.30	--
Cultivate	.31	.20	.06	.11	.30	--
Hand weed control	--	--	--	--	3.75	--
Poison x 5 (ground)	--	--	.90	1.05	.75	6.50
Poison x 4 (custom air)	--	--	2.80	--	.16	5.20
Defoliate	--	--	.18	.21	.15	2.12
Harvest	--	--	7.81	12.84	2.50	--
Haul	.51	.61	.26	.66	.64	--
Harvest	--	--	4.96	8.15	1.58	--
Haul	.13	.15	.07	.16	.16	--
Shred stalks	.47	.29	.03	.09	.45	--
Disk	.36	.23	.17	.29	.35	--
Disk	.36	.23	.17	.29	.35	--
Disk	.36	.23	.17	.29	.35	--
Bed	.31	.20	.10	.16	.30	--
Chisel & incorporate herbicides	.39	.25	.19	.32	.38	5.88
Seed	.36	.23	.20	.33	.35	--
Totals	7.13	4.96	19.30	27.19	22.06	43.69
Total costs excluding ginning			$124.33			

Table 24. Cotton production costs per acre on clay soil, 4-row equipment, solid planted, fall seedbed preparation, and more efficient practic, Delta area of Mississippi.

Operation	Tractor costs		Equipment costs		Labor costs	Materia costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollar
Row condition & incorporate herbicides	.37	.24	.14	.29	.36	5.88
Plant	.37	.24	.21	.44	.72	4.95
Tractor & trailer	.10	.12	.06	.13	.40	--
Cultivate	.39	.25	.08	.14	.38	--
Fertilize	.43	.27	.10	.20	.42	11.48
Poison thrips	--	--	.18	.21	.15	.34
Cultivate & postemerge	.43	.27	.11	.19	.42	.43
Cultivate & postemerge	.43	.27	.11	.19	.42	2.43
Hand weed control	--	--	--	--	5.25	--
Cultivate & postemerge	.37	.24	.09	.17	.36	1.93
Cultivate & postemerge	.37	.24	.09	.17	.36	2.43
Hand weed control	--	--	--	--	3.75	--
Poison x 5 (ground)	--	--	.90	1.05	.75	6.50
Poison x 2 (custom air)	--	--	1.40	--	.08	2.60
Defoliate	--	--	.18	.21	.15	2.12
Harvest	--	--	7.81	12.84	2.50	--
Haul	.51	.61	.26	.66	.64	--
Harvest	--	--	4.96	8.15	1.58	--
Haul	.13	.15	.07	.16	.16	--
Cut stalks	.47	.29	.03	.09	.45	--
Chisel	.47	.29	.08	.17	.45	--
Disk	.36	.23	.17	.29	.35	--
Bed	.31	.20	.10	.16	.30	--
Disk	.36	.23	.17	.29	.35	--
Rebed	.36	.23	.20	.33	.35	--
Totals	6.23	4.37	17.50	26.53	21.10	41.09
Total costs excluding ginning			$116.82			

Table 25. Cotton production costs per acre on clay soils, 6-row equipment, solid planted, fall seedbed preparation, and more efficient practices, Delta area of Mississippi.

Operation	Tractor costs		Equipment costs		Labor costs	Materials costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Rod condition & incorporate herbicides	.28	.18	.17	.36	.27	5.88
Plant	.28	.18	.21	.43	.54	4.95
Tractor & trailer	.10	.12	.06	.13	.40	--
Cultivate	.33	.21	.10	.18	.32	--
Fertilize	.33	.21	.11	.21	.32	11.48
Poison thrips	--	--	.18	.21	.15	.34
Cultivate & postemerge	.37	.24	.14	.25	.36	.43
Cultivate & postemerge	.37	.24	.14	.25	.36	2.43
Hand weed control	--	--	--	--	5.25	--
Cultivate & postemerge	.28	.18	.10	.19	.27	1.93
Cultivate & postemerge	.28	.18	.10	.19	.27	2.43
Hand weed control	--	--	--	--	3.75	--
Poison x 5 (ground)	--	--	.90	1.05	.75	6.50
Poison x 2 (custom air)	--	--	1.40	--	.08	2.60
Defoliate	--	--	.18	.21	.15	2.12
Harvest	--	--	7.81	12.84	2.50	--
Haul	.51	.61	.26	.66	.64	--
Harvest	--	--	4.96	8.15	1.58	--
Haul	.13	.15	.07	.16	.16	--
Shred stalks	.47	.29	.03	.09	.45	--
Shovel	.47	.29	.08	.17	.45	--
Disk	.22	.14	.17	.29	.21	--
Level	.20	.13	.11	.18	.20	--
Disk	.22	.14	.17	.29	.21	--
Seed	.25	.16	.14	.23	.24	--
Totals	5.09	3.65	17.59	26.72	19.88	41.09
Total costs excluding ginning			$114.02			

Table 26. Cotton production costs per acre on clay soil, 6-row equipment, solid planted, spring seedbed preparation, and usual farm practices, Delta area of Mississippi.

Operation	Tractor costs		Equipment costs		Labor costs	Material costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Row condition	.28	.18	.17	.36	.27	--
Plant	.28	.18	.21	.43	.54	4.95
Tractor & trailer	.10	.12	.06	.13	.40	--
Cultivate	.33	.21	.10	.18	.32	--
Fertilize	.33	.21	.11	.21	.32	11.48
Poison thrips	--	--	.18	.21	.15	.34
Cultivate & postemerge	.37	.24	.14	.25	.36	.43
Cultivate & postemerge	.37	.24	.14	.25	.36	2.43
Hand weed control	--	--	--	--	6.00	--
Cultivate & postemerge	.28	.18	.10	.19	.27	1.93
Cultivate & postemerge	.28	.18	.10	.19	.27	2.43
Cultivate	.22	.14	.07	.12	.21	--
Cultivate	.22	.14	.07	.12	.21	--
Hand weed control	--	--	--	--	4.50	--
Poison x 5 (ground)	--	--	.90	1.05	.75	6.50
Poison x 4 (custom air)	--	--	2.80	--	.16	5.20
Defoliate	--	--	.18	.21	.15	2.12
Harvest	--	--	7.81	12.84	2.50	--
Haul	.51	.61	.26	.66	.64	--
Harvest	--	--	4.96	8.15	1.58	--
Haul	.13	.15	.07	.16	.16	--
Cut stalks	.47	.29	.03	.09	.45	--
Disk	.22	.14	.17	.29	.21	--
Disk	.22	.14	.17	.29	.21	--
Disk	.22	.14	.17	.29	.21	--
Bed	.20	.13	.11	.18	.20	--
Disk & incorporate herbicides	.28	.18	.21	.37	.27	5.88
Rebed	.25	.16	.21	.35	.24	--
Totals	5.56	3.96	19.50	27.57	21.91	43.69
Total costs excluding ginning			$122.19			

conditions and meshes well into an overall farm organization in the Delta area. When compared to cotton, soybean direct production costs average $80 to $90 less per acre. This magnitude of difference between crops in operating capital requirements may be significant in cases where capital is a restrictive resource.

As shown in Tables 27-32, use of 6-row equipment in soybean production resulted in production cost reductions of $1.64 to $2.59 per acre.

Producers usually incorporated one of the following weed control programs in their soybean production system. They either utilized a postemergence chemical application, an incorporated preplant herbicide plus a postemergence application, or a post-plant, preemergence applied chemical plus a postemergence application.

In addition to equipment size and weed control methods, the primary variable in the cost of soybean production were the expenditures incurred in seedbed preparation. The most efficient producers were able to reduce the number of field operations, hence reducing their cost of production.

Soybeans - Clay Soils

Tables 33-36 contain budgets for soybeans produced on the heavier textured soils in the Yazoo-Mississippi Delta. The major difference between these budgets and sandy soil budgets is the use of an incorporated herbicide in all the clay soil budgets.

Using 6-row equipment resulted in cost reductions of $2.24 to $3.07 per acre when compared to 4-row equipment on clay soils. The more efficient producers achieved their savings in production costs by reducing seedbed preparation inputs.

Corn (Grain and Silage)

Excellent yields have been reported for corn grown in the Delta area of Mississippi when adequate water is available and when "sandy" soils as described in this publication are utilized.[8/] Rainfall patterns in this area indicate that to insure proper moisture conditions at the proper time, land utilized for corn production should be subject to irrigation. Corn was generally planted from March 25-April 15. Grain harvest usually occurred from September 1 to October 15 while silage harvesting was done most often from July 15-August 15.

Tables 37-40 contain the usual inputs utilized for corn grain and corn silage production in the Yazoo-Mississippi Delta utilizing 4- and 6-row equipment. The primary difference in costs, aside from the generally observed reduction achieved by the larger size equipment, was between harvesting costs for grain and silage. When harvested for silage, the costs include the addition of 10 lb. of feed grade urea and 10 lb. of limestone added to each ton of as-cut ensilage material.

Other publications have shown these added harvesting costs to be economically advantageous when tied to a beef slaughter feeding operation on a cotton-soybean

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8/ Grissom, Perrin, W. A. Raney, and Peter Hogg, "Crop Response to Irrigation in the Yazoo-Mississippi Delta, Miss. Agri. Expt. Sta. Bul. 531, May 1955.

Table 27. Soybean production costs per acre on sandy soil, 4-row equipment, Delta area of Mississippi.

Operation	Tractor costs		Equipment costs		Labor costs	Materials costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Row condition	.31	.20	.12	.24	.30	--
Plant	.31	.20	.14	.29	.60	3.35
Tractor & trailer	.03	.03	.02	.03	--	--
Cultivate	.39	.25	.08	.14	.38	--
Cultivate	.31	.20	.06	.11	.30	--
Cultivate & postemerge	.37	.24	.09	.17	.36	1.80
Cultivate	.31	.20	.06	.11	.30	--
Harvest	--	--	2.26	3.24	.50	--
Haul	--	--	1.05	.05	.30	--
Chisel	.47	.29	.08	.17	.45	--
Chisel	.47	.29	.08	.17	.45	--
Disk	.36	.23	.17	.29	.35	--
Harrow	.31	.20	.04	.07	.30	--
Disk	.36	.23	.17	.29	.35	--
Bed	.31	.20	.10	.16	.30	--
Totals	4.31	2.76	4.52	5.53	5.24	5.15
Total specified costs	$27.51					

Table 28. Soybean production costs per acre on sandy soil, 4-row equipment, incorporated preplant herbicides, Delta area of Mississippi.

Operation	Tractor costs		Equipment costs		Labor costs	Material costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Row condition	.31	.20	.12	.24	.30	--
Plant	.31	.20	.14	.29	.60	3.35
Tractor & trailer	.03	.03	.02	.03	--	--
Cultivate	.39	.25	.08	.14	.38	--
Cultivate	.31	.20	.06	.11	.30	--
Cultivate & postemerge	.37	.24	.09	.17	.36	1.80
Cultivate	.31	.20	.06	.11	.30	--
Harvest	--	--	2.26	3.24	.50	--
Haul	--	--	1.05	.05	.30	--
Chisel	.47	.29	.08	.17	.45	--
Chisel	.47	.29	.08	.17	.45	--
Disk	.36	.23	.17	.29	.35	--
Harrow	.31	.20	.04	.07	.30	--
Disk	.36	.23	.17	.29	.35	--
Bed	.31	.20	.10	.16	.30	--
Incorporate herbicides	.31	.20	.12	.24	.30	1.47
Totals	4.62	2.96	4.64	5.77	5.54	6.62
Total specified costs	$30.15					

ble 29. Soybean production costs per acre on sandy soil, 4-row equipment, more efficient practices, Delta area of Mississippi.

(eration	Tractor costs		Equipment costs		Labor costs	Materials costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Fv condition	.31	.20	.12	.24	.30	--
Plnt	.31	.20	.14	.29	.60	3.35
Tictor & trailer	.03	.03	.02	.03	--	--
Apply herbicides	--	--	.18	.21	.15	3.75
C.tivate	.39	.25	.08	.14	.38	--
C.tivate	.31	.20	.06	.11	.36	--
C.tivate & postemerge	.37	.24	.09	.17	.30	1.80
Harvest	--	--	2.26	3.24	.50	--
Hul	--	--	1.05	.05	.30	--
C sel	.47	.29	.08	.17	.45	--
C sel	.47	.29	.08	.17	.45	--
D k	.36	.23	.17	.29	.35	--
H row	.31	.20	.04	.07	.30	--
Totals	3.33	2.13	4.37	5.18	4.44	8.90

Total specified costs $28.35

e 30. Soybean production costs per acre on sandy soil, 6-row equipment, Delta area of Mississippi.

ration	Tractor costs		Equipment costs		Labor costs	Materials costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
e condition	.23	.15	.15	.30	.23	--
nt	.23	.15	.16	.33	.46	3.35
ctor & trailer	.03	.03	.02	.03	--	--
ivate	.33	.21	.10	.18	.32	--
ivate	.22	.14	.07	.12	.21	--
ivate & postemerge	.28	.18	.10	.19	.27	1.80
ivate	.22	.14	.07	.12	.21	--
rest	--	--	2.26	3.24	.50	--
	--	--	1.05	.05	.30	--
sel	.47	.29	.08	.17	.45	--
el	.47	.29	.08	.17	.45	--
	.22	.14	.17	.29	.21	--
ow	.16	.10	.03	.06	.15	--
	.22	.14	.17	.29	.21	--
	.20	.13	.11	.18	.20	--
tals	3.28	2.09	4.62	5.72	4.17	5.15

tal specified costs $25.03

Table 31. Soybean production costs per acre on sandy soil, 6-row equipmen incorporated preplant herbicides, Delta area of Mississippi.

Operation	Tractor costs		Equipment costs		Labor	Materi s
	Direct	Fixed	Direct	Fixed	costs	cost
	Dollars	Dollars	Dollars	Dollars	Dollars	Dolla
Row condition	.23	.15	.15	.30	.23	--
Plant	.23	.15	.16	.33	.46	3.3
Tractor & trailer	.03	.03	.02	.03	--	--
Cultivate	.33	.21	.10	.18	.32	--
Cultivate	.22	.14	.07	.12	.21	--
Cultivate & postemerge	.28	.18	.10	.19	.27	1.8
Cultivate	.22	.14	.07	.12	.21	--
Harvest	--	--	2.26	3.24	.50	--
Haul	--	--	1.05	.05	.30	--
Chisel	.47	.29	.08	.17	.45	--
Chisel	.47	.29	.08	.17	.45	--
Disk	.22	.14	.17	.29	.21	--
Harrow	.16	.10	.03	.06	.15	--
Disk	.22	.14	.17	.29	.21	--
Bed	.20	.13	.11	.18	.20	--
Incorporate herbicides	.23	.15	.15	.30	.23	1.4
Totals	3.51	2.24	4.77	6.02	4.40	6.6

Total specified costs $27.56

Table 32. Soybean production costs per acre on sandy soil, 6-row equipmen more efficient practices, Delta area of Mississippi.

Operation	Tractor costs		Equipment costs		Labor	Mater ls
	Direct	Fixed	Direct	Fixed	costs	cos
	Dollars	Dollars	Dollars	Dollars	Dollars	Doll s
Row condition	.23	.15	.15	.30	.23	-
Plant	.23	.15	.16	.33	.46	3.
Tractor & trailer	.03	.03	.02	.03	--	-
Apply herbicides	--	--	.18	.21	.15	3.
Cultivate	.33	.21	.10	.18	.32	-
Cultivate	.22	.14	.07	.12	.21	-
Cultivate & postemerge	.28	.18	.10	.19	.27	1.
Harvest	--	--	2.26	3.24	.50	-
Haul	--	--	1.05	.05	.30	-
Chisel	.47	.29	.08	.17	.45	-
Chisel	.47	.29	.08	.17	.45	-
Disk	.22	.14	.17	.29	.21	-
Harrow	.16	.10	.03	.06	.15	-
Totals	2.64	1.68	4.45	5.34	3.70	8.

Total specified costs $26.71

ble 33. Soybean production costs per acre on clay soils, 4-row equipment, Delta area of Mississippi.

eration	Tractor costs		Equipment costs		Labor costs	Materials costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
w condition	.31	.20	.12	.24	.30	--
ant	.31	.20	.14	.29	.60	3.35
actor & trailer	.03	.03	.02	.03	--	--
ltivate	.39	.25	.08	.14	.38	--
ltivate	.31	.20	.06	.11	.30	--
ltivate & postemerge	.37	.24	.09	.17	.36	1.80
ltivate	.31	.20	.06	.11	.30	
rvest	--	--	2.26	3.24	.50	--
ul	--	--	1.05	.05	.30	--
sk	.36	.23	.17	.29	.35	--
sk	.36	.23	.17	.29	.35	--
sk	.36	.23	.17	.29	.35	--
rrow	.31	.20	.04	.07	.30	--
d	.31	.20	.10	.16	.30	--
sk & incorporate						
rbicides	.39	.25	.19	.32	.38	2.94
otals	4.12	2.66	4.72	5.80	5.07	8.09

otal costs $30.46

ble 34. Soybean production costs per acre on clay soil, 4-row equipment, more efficient practices, Delta area of Mississippi.

ration	Tractor costs		Equipment costs		Labor costs	Materials costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
condition	.31	.20	.12	.24	.30	--
nt	.31	.20	.14	.29	.60	3.35
ctor & trailer	.03	.03	.02	.03	--	--
ly herbicide	--	--	.18	.21	.15	3.75
tivate	.39	.25	.08	.14	.38	--
tivate	.31	.20	.06	.11	.30	--
tivate	.31	.20	.06	.11	.30	--
vest	--	--	2.26	3.24	.50	--
l	--	--	1.05	.05	.30	--
k	.36	.23	.17	.29	.35	--
k	.36	.23	.17	.29	.35	--
k & incorporate						
rbicides	.39	.25	.19	.32	.38	2.94
row	.31	.20	.04	.07	.30	--
otals	3.08	1.99	4.54	5.39	4.21	10.04

otal costs $29.25

Table 35. Soybean production costs per acre on clay soil, 6-row equipment Delta area of Mississippi.

Operation	Tractor costs		Equipment costs		Labor	Mater ls
	Direct	Fixed	Direct	Fixed	costs	cos
	Dollars	Dollars	Dollars	Dollars	Dollars	Doll s
Row condition	.23	.15	.15	.30	.23	-
Plant	.23	.15	.16	.33	.46	3.
Tractor & trailer	.03	.03	.02	.03	--	-
Cultivate	.33	.21	.10	.18	.32	-
Cultivate	.22	.14	.07	.12	.21	-
Cultivate & postemerge	.28	.18	.10	.19	.27	1.
Cultivate	.22	.14	.07	.12	.21	-
Harvest	--	--	2.26	3.24	.50	-
Haul	--	--	1.05	.05	.30	-
Disk	.22	.14	.17	.29	.21	-
Disk	.22	.14	.17	.29	.21	-
Disk	.22	.14	.17	.29	.21	-
Harrow	.16	.10	.03	.06	.15	-
Bed	.20	.13	.11	.18	.20	-
Disk & incorporate herbicides	.28	.18	.21	.37	.27	2.
Totals	2.84	1.83	4.84	6.04	3.75	8.
Total costs $27.39						

Table 36. Soybean production costs per acre on clay soil, 6-row equipment, more efficient practices, Delta area of Mississippi.

Operation	Tractor costs		Equipment costs		Labor	Materi
	Direct	Fixed	Direct	Fixed	costs	cost
	Dollars	Dollars	Dollars	Dollars	Dollars	Dolla
Row condition	.23	.15	.15	.30	.23	--
Plant	.23	.15	.16	.33	.46	3.3
Tractor & trailer	.03	.03	.02	.03	--	--
Apply herbicide	--	--	.18	.21	.15	3.7
Cultivate	.33	.21	.10	.18	.32	--
Cultivate	.22	.14	.07	.12	.21	--
Cultivate	.22	.14	.07	.12	.21	--
Harvest	--	--	2.26	3.24	.50	--
Haul	--	--	1.05	.05	.30	--
Disk	.22	.14	.17	.29	.21	--
Disk	.22	.14	.17	.29	.21	--
Disk & incorporate herbicides	.28	.18	.21	.37	.27	2.9
Harrow	.16	.10	.03	.06	.15	--
Totals	2.14	1.38	4.64	5.59	3.22	10.0
Total costs $27.01						

Table 37. Corn (for grain) production costs per acre on sandy soil, 4-row equipment, and usual farm practices, Delta area of Mississippi.

Operation	Tractor costs		Equipment costs		Labor costs	Materials costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
k condition	.39	.25	.15	.30	.38	--
nt & preemerge	.39	.25	.18	.37	.38	6.08
ctor & trailer	.18	.12	.06	.10	.23	--
tivate & sidedress	.43	.27	.11	.19	.42	10.00
tivate	.31	.20	.06	.11	.30	--
igate	--	--	3.68	6.50	3.90	--
son	--	--	.85	--	.08	2.72
vest	.78	.49	3.58	5.16	.75	--
l	--	--	3.15	.15	.90	--
ring & storage	--	--	2.00	5.00	--	--
sel	.47	.29	.08	.17	.45	--
sel	.47	.29	.08	.17	.45	--
c	.36	.23	.17	.29	.35	--
c	.36	.23	.17	.29	.35	--
ilize	.43	.27	.11	.20	.42	10.50
tor & trailer	.26	.16	.08	.14	.32	--
e	.31	.20	.10	.16	.30	--
d	.31	.20	.10	.16	.30	--
tals	5.45	3.45	14.71	19.46	10.28	29.30

tal specified costs $82.65

Table 38. Corn (for grain) production costs per acre on sandy soil, 6-row equipment, and usual farm practices, Delta area of Mississippi.

Operation	Tractor costs		Equipment costs		Labor costs	Materials costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Row condition	.31	.20	.19	.40	.30	-
Plant & preemerge	.31	.20	.22	.45	.30	6.8
Tractor & trailer	.18	.12	.06	.10	.23	-
Cultivate & sidedress	.37	.24	.14	.25	.36	10.0
Cultivate	.22	.14	.07	.12	.21	-
Irrigate	--	--	3.68	6.50	3.90	-
Poison	--	--	.85	--	.08	2.2
Harvest	.78	.49	3.58	5.16	.75	-
Haul	--	--	3.15	.15	.90	-
Drying & storage	--	--	2.00	5.00	--	-
Chisel	.47	.29	.08	.17	.45	-
Chisel	.47	.29	.08	.17	.45	-
Disk	.22	.14	.17	.29	.21	-
Disk	.22	.14	.17	.29	.21	-
Fertilize	.33	.21	.11	.21	.32	10.0
Tractor & trailer	.26	.16	.08	.14	.32	-
Bed	.20	.13	.11	.18	.20	-
Rebed	.20	.13	.11	.18	.20	-
Totals	4.54	2.88	14.85	19.76	9.39	29.0

Total specified costs $80.72

ble 39. Corn (for silage) production costs per acre on sandy soil, 4-row equipment, and usual farm practices, Delta area of Mississippi.

eration	Tractor costs		Equipment costs		Labor costs	Materials costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
w condition	.39	.25	.15	.30	.38	--
ant & preemerge	.39	.25	.18	.37	.38	6.08
actor & trailer	.18	.12	.06	.10	.23	--
ltivate & sidedress	.43	.27	.11	.19	.42	10.00
ltivate	.31	.20	.06	.11	.30	--
rigate	--	--	3.68	6.50	3.90	--
ison	--	--	.85	--	.08	2.72
rvest	1.55	.98	3.28	5.64	1.50	--
ul x 3	3.66	2.31	2.46	6.42	3.00	--
load	1.55	.98	.51	.85	1.50	4.05
isel	.47	.29	.08	.17	.45	--
isel	.47	.29	.08	.17	.45	--
sk	.36	.23	.17	.29	.35	--
sk	.36	.23	.17	.29	.35	--
rtilize	.43	.27	.11	.20	.42	10.50
actor & trailer	.26	.16	.08	.14	.32	--
d	.31	.20	.10	.16	.30	--
bed	.31	.20	.10	.16	.30	--
Totals	11.43	7.23	12.23	22.06	14.63	33.35
Total specified costs	$100.93					

Table 40. Corn (for silage) production costs per acre on sandy soil, 6-row equipment, and usual farm practices, Delta area of Mississippi.

Operation	Tractor costs		Equipment costs		Labor costs	Materi costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dolla
Row condition	.31	.20	.19	.40	.30	--
Plant & preemerge	.31	.20	.22	.45	.30	6.0
Tractor & trailer	.18	.12	.06	.10	.23	--
Cultivate & sidedress	.37	.24	.14	.25	.36	10.0
Cultivate	.22	.14	.07	.12	.21	--
Irrigate	--	--	3.68	6.50	3.90	--
Poison	--	--	.85	--	.08	2.7
Harvest	1.55	.98	3.28	5.64	1.50	--
Haul x 3	3.66	2.31	2.46	6.42	3.00	--
Unload	1.55	.98	.51	.85	1.50	4.0
Chisel	.47	.29	.08	.17	.45	--
Chisel	.47	.29	.08	.17	.45	--
Disk	.22	.14	.17	.29	.21	--
Disk	.22	.14	.17	.29	.21	--
Fertilize	.33	.21	.11	.21	.32	10.5
Tractor & trailer	.26	.16	.08	.14	.32	--
Bed	.20	.13	.11	.18	.20	--
Rebed	.20	.13	.11	.18	.20	--
Totals	10.52	6.66	12.37	22.36	13.74	33.3

Total specified costs $99.00

tm in the Delta area of Mississippi.[9, 1, 11, 12]

Small Grain (Grain and Silage)

Small grain (oats and/or wheat) pro-ction either as grain or silage has result-in an overall increase in the efficiency h which fixed resources were utilized many farms in the Delta area of Missis-ipi.

Tables 41-44 indicate production costs f small grain utilizing 4- and 6-row ipment to produce either grain or si-. The greater silage production costs e a result of increased harvesting ts. The small number of field opera-ns resulted in only a small reduction in ts by utilizing 6-row rather than 4-row ipment.

Grain Sorghum (Grain and Silage)

Grain sorghum production fits well in-he overall cotton-soybean farm orga-tion on some farms in the Yazoo-issippi Delta area. Early grain sor-ns were generally planted in early il and harvested as grain in late July arly August. Harvest of early planted hum silage occurred in early July. ever, a wide range in grain sorghum ting dates is possible, extending from l 10 through July 10, with harvesting s being closely tied to planting date. ables 45-48 contain budgets for grain um (grain and silage) production ing either 4- or 6-row equipment.

Days Suitable for Fieldwork

ime is one additional dimension h must be considered when deriving ptimum farm organization. There be an opportunity to perform all the tasks inherent with the employment of the various production functions utilized on a given farm in the Delta area of Mississippi. Often optimum solutions will turn on the amount of space that labor and equipment can cover within an allowable time span.

Detailed considerations of this aspect of proportional time available for fieldwork have been reported.[13] Table 49 presents the usual dates that the specified operations for the crops discussed in this report are carried out. The range of time for many seedbed preparation operations is quite wide due to the possibility of doing such work after fall harvest as well as in the spring. Planting dates for grain sorghum are quite wide because of the possibility of late planting for silage production.

Data in Tables 50 through 57 have been obtained using procedures similar to

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9/ Pund, William A., "Silage Feeding Tests in Delta", **Mississippi Farm Research,** Vol. 33, No. 4, p. 2, Miss. Agri. Expt. Sta., 1969.

10/ Pund, William A., and Peter G. Hogg, "Steers on Urea Treated Corn Silage", **Mississippi Farm Research,** Vol. 31, No. 4, p. 6, Miss. Agri. Expt. Sta., 1968.

11/ Heagler, Arthur M., Bill Bolton, and Peter G. Hogg, "Costs of Beef Gains with High-Energy Corn Silage Mississippi River Delta Area". Louisiana State University, D.A.E. Research Report No. 365, June 1967.

12/ Pund, William A., J. M. Anderson, Robert W. Rogers, and E. G. Morrison, "Comparing Systems of Finishing Beef," **Mississippi Farm Research,** Vol. 35, No. 2, p. 4,5,8, Miss. Agri. Expt. Sta., 1972.

13/ Bolton, Bill, J. B. Penn, Fred T. Cooke, Jr., and Arthur M. Heagler, "Days Suitable for Fieldwork, Mississippi River Delta Cotton Area". Louisiana State University, D.A.E. Research Report No. 384, November 1968.

Table 41. Small grain (for grain) production costs per acre on all soils, 4-row equipment, and usual farm practices, Delta area of Mississi

Operation	Tractor costs		Equipment costs		Labor costs	Materi cost
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dolla
Harrow	.31	.20	.04	.07	.30	--
Plant	.31	.20	.13	.28	.30	3.8
Tractor & trailer	.09	.10	.05	.11	.30	--
Fertilize	--	--	1.50	--	.08	5.7
Poison	--	--	.85	--	.08	.7
Harvest	.51	.32	2.26	3.24	.50	--
Haul	--	--	1.05	.05	.30	--
Burn	--	--	--	--	.10	--
Disk	.36	.23	.17	.29	.35	--
Chisel	.47	.29	.08	.17	.45	--
Disk	.36	.23	.17	.29	.35	--
Harrow	.31	.20	.04	.07	.30	--
Totals	2.72	1.77	6.34	4.57	3.41	10.3

Total specified costs $29.11

Table 42. Small grain (for grain) production costs per acre on all soils, 6-row equipment, and usual farm practices, Delta area of Mississi

Operation	Tractor costs		Equipment costs		Labor costs	Materi cost
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dolla
Harrow	.16	.10	.03	.06	.15	--
Plant	.31	.20	.13	.28	.30	3.8
Tractor & trailer	.09	.10	.05	.11	.30	--
Fertilize	--	--	1.50	--	.08	5.7
Poison	--	--	.85	--	.08	.7
Harvest	.51	.32	2.26	3.24	.50	--
Haul	--	--	1.05	.05	.30	--
Burn	--	--	--	--	.10	--
Disk	.22	.14	.17	.29	.21	--
Chisel	.47	.29	.08	.17	.45	--
Disk	.22	.14	.17	.29	.21	--
Harrow	.16	.10	.03	.06	.15	--
Totals	2.14	1.39	6.32	4.55	2.83	10.3

Total specified costs $27.53

ble 43. Small grain (for silage) production costs per acre on all soils, 4-row equipment, and usual farm practices, Delta area of Mississippi.

eration	Tractor costs		Equipment costs		Labor costs	Materials costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Hrow	.31	.20	.04	.07	.30	--
Pnt	.31	.20	.13	.28	.30	3.86
Tctor & trailer	.09	.10	.05	.11	.30	--
Ftilize	--	--	1.50	--	.08	5.74
Pson	--	--	.85	--	.08	.70
Hvest	.53	.33	1.12	1.92	.51	--
Hl	1.06	.66	.56	1.46	1.02	--
Bwer	.53	.33	.14	.29	1.02	1.72
Bn	--	--	--	--	.10	--
)k	.36	.23	.17	.29	.35	--
Esel	.47	.29	.08	.17	.45	--
)k	.36	.23	.17	.29	.35	--
Lrow	.31	.20	.04	.07	.30	--
otals	4.33	2.77	4.85	4.95	5.16	12.02

otal specified costs $34.08

e 44. Small grain (for silage) production costs per acre on all soils, 6-row equipment, and usual farm practices, Delta area of Mississippi.

ation	Tractor costs		Equipment costs		Labor costs	Materials costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
ow	.16	.10	.03	.06	.15	--
t	.31	.20	.13	.28	.30	3.86
tor & trailer	.09	.10	.05	.11	.30	--
ilize	--	--	1.50	--	.08	5.74
on	--	--	.85	--	.08	.70
est	.53	.33	1.12	1.92	.51	--
	1.06	.66	.56	1.46	1.02	--
er	.53	.33	.14	.29	1.02	1.72
	--	--	--	--	.10	--
	.22	.14	.17	.29	.21	--
el	.47	.29	.08	.17	.45	--
	.22	.14	.17	.29	.21	--
ow	.16	.10	.03	.06	.15	--
tals	3.75	2.39	4.83	4.93	4.58	12.02

al specified costs $32.50

Table 45. Grain sorghum (for grain) production costs per acre on all soils, 4-row equipment, and usual farm practices, Delta area of Mississi

Operation	Tractor costs		Equipment costs		Labor costs	Materi cost
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dolla
Row condition	.31	.20	.12	.24	.30	--
Plant & preemerge	.31	.20	.14	.29	.30	6.8
Tractor & trailer	.07	.08	.04	.08	.23	--
Cultivate	.39	.25	.08	.14	.38	--
Cultivate & sidedress	.43	.27	.11	.19	.42	8.6
Cultivate	.31	.20	.06	.10	.30	--
Harvest	.51	.32	2.26	3.24	.50	--
Haul	--	--	3.15	.15	.90	--
Dry & store	--	--	2.50	4.00	--	--
Disk	.36	.23	.17	.29	.35	--
Disk	.36	.23	.17	.29	.35	--
Chisel	.47	.29	.08	.17	.45	--
Harrow	.31	.20	.04	.07	.30	--
Bed	.31	.20	.10	.16	.30	--
Totals	4.14	2.67	9.02	9.41	5.08	15.4
Total specified costs	$45.73					

Table 46. Grain sorghum (for grain) production costs per acre on all soils, 6-row equipment, and usual farm practices, Delta area of Mississi

Operation	Tractor costs		Equipment costs		Labor costs	Materi cost
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dolla
Row condition	.23	.15	.15	.30	.23	--
Plant & preemerge	.23	.15	.16	.33	.23	6.8
Tractor & trailer	.07	.08	.04	.08	.23	--
Cultivate	.33	.21	.10	.18	.32	--
Cultivate & sidedress	.37	.24	.14	.25	.36	8.6
Cultivate	.22	.14	.07	.12	.21	--
Harvest	.51	.32	2.26	3.24	.50	--
Haul	--	--	3.15	.15	.90	--
Dry & store	--	--	2.50	4.00	--	--
Disk	.22	.14	.17	.29	.21	--
Disk	.22	.14	.17	.29	.21	--
Chisel	.47	.29	.08	.17	.45	--
Harrow	.16	.10	.03	.06	.15	--
Bed	.20	.13	.11	.18	.20	--
Totals	3.23	2.09	9.13	9.64	4.20	15.4
Total specified costs	$43.70					

ble 47. Grain sorghum (for silage) production costs per acre on all soils, 4-row equipment, and usual farm practices, Delta area of Mississippi.

eration	Tractor costs		Equipment costs		Labor costs	Materials costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
w condition	.31	.20	.12	.24	.30	--
int & preemerge	.31	.20	.14	.29	.30	6.80
ctor & trailer	.07	.08	.04	.08	.23	--
tivate	.39	.25	.08	.14	.35	--
tivate & sidedress	.43	.27	.11	.19	.42	8.61
tivate	.31	.20	.06	.10	.30	--
vest	1.08	.69	2.30	3.95	1.05	--
l x 2	1.72	1.08	1.16	3.00	2.10	--
oading	1.09	.69	.29	.60	2.10	1.69
k	.36	.23	.17	.29	.35	--
k	.36	.23	.17	.29	.35	--
sel	.47	.29	.08	.17	.45	--
row	.31	.20	.04	.07	.30	--
	.31	.20	.10	.16	.30	--
otals	7.52	4.81	4.86	9.57	8.90	17.10
otal specified costs	$52.76					

e 48. Grain sorghum (for silage) production costs per acre on all soils, 6-row equipment, and usual farm practices, Delta area of Mississippi.

ation	Tractor costs		Equipment costs		Labor costs	Materials costs
	Direct	Fixed	Direct	Fixed		
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
condition	.23	.15	.15	.30	.23	--
t & preemerge	.23	.15	.16	.33	.23	6.80
tor & trailer	.07	.08	.04	.08	.23	--
ivate	.33	.21	.10	.18	.32	--
ivate & sidedress	.37	.24	.14	.25	.36	8.61
ivate	.22	.14	.07	.12	.21	--
est	1.08	.69	2.30	3.95	1.05	--
x 2	1.72	1.08	1.16	3.00	2.10	--
ading	1.09	.69	.29	.60	2.10	1.69
	.22	.14	.17	.29	.21	--
	.22	.14	.17	.29	.21	--
el	.47	.29	.08	.17	.45	--
w	.16	.10	.03	.06	.15	--
	.20	.13	.11	.18	.20	--
tals	6.61	4.23	4.97	9.80	8.05	17.10
tal specified costs	$50.76					

Table 49. Usual dates for specified operations and selected crops, Delta area of Mississippi.

Operation	Cotton[1/]	Soybeans[2/]	Corn[1/]	Small Grain[2/]	Grain Sorghum[3/]
	Dates (Month/Day)				
Row condition	4/15-5/20	5/10-6/20	3/25-4/25	[4/] 9/20-11/20	4/10-6/30
Plant	4/15-5/20	5/10-6/20	3/25-4/25	9/20-11/20	4/10-6/30
Cultivate	5/1-6/10	5/25-7/5	--	--	4/25-7/10
Insecticide application	5/5-6/5	--	--	3/15-4/30	--
Cultivate	--	6/1-7/15	--	--	--
Cultivate & sidedress	--	--	4/10-5/5	--	5/5-7/20
Cultivate & postemerge	5/10-6/15	6/10-7/15	--	--	--
Cultivate & postemerge	5/15-6/25	--	--	--	--
Hand weed control	6/1-7/15	--	--	--	--
Cultivate & postemerge	6/1-7/5	--	--	--	--
Cultivate & postemerge	6/10-7/15	--	--	--	--
Cultivate	6/15-7/15	6/20-7/31	4/20-5/20	--	6/1-7/31
Cultivate & postemerge	7/1-7/31	--	--	--	--
Hand weed control	7/16-8/30	--	--	--	--
Insecticide application (ground)	7/15-9/20	--	--	--	--
Insecticide application (custom air)	7/15-9/20	--	6/15-7/15	--	--
Defoliate	9/25-10/20	--	--	--	--
Irrigate	--	--	6/15-7/15	--	--
Harvest (first)	10/1-11/10	9/15-12/15	--	--	--
Harvest (second)	10/25-11/30	--	--	--	--
Harvest for grain	--	--	9/1-10/10	5/25-6/15	8/1-10/20
Harvest for silage	--	--	7/15-8/20	5/15-5/31	7/20-10/25
Cut stalks	10/25-4/10	--	--	--	--
Subsoil	10/25-4/10	--	--	--	--
Chisel	10/25-4/15	--	8/15-3/31	9/1-11/1	10/15-6/15
Chisel	10/25-4/15	--	9/1-4/15	--	--
Disk	--	10/15-5/10	9/1-4/15	9/1-11/1	10/15-6/15
Disk	10/25-4/15	10/15-5/10	9/1-4/15	9/1-11/1	10/15-6/15
Disk	10/25-4/15	3/15-6/1	--	--	--
Harrow	--	3/15-6/1	--	9/1-11/1	10/15-6/15
Disk & incorporate herbicides	--	3/15-6/1	--	--	--
Bed	10/25-4/15	3/15-6/1	3/1-4/15	--	10/15-6/15
Rebed & fertilize	3/15-4/25	--	[5/] 3/1-4/15	--	--
Fertilize	--	--	3/1-4/15	2/15-4/15	--

1/ Typical of sandy soil. 2/ Typical of clay soils. 3/ Operations reflect those used at the Delta

tse indicated in the above publication. Tese estimates were obtained from wather records maintained at Stoneville, Mssissippi, during the period 1931-1967, inlusive. Days available for tillage and n-tillage field work have been esti-nted for various time frames for both sdy and clay soils.

Summary

Data collected from a total of 280 fmers in the Delta area of Mississippi ding the period 1965-68 have been used tconstruct crop budgets for the produc-n of cotton, soybeans, corn (grain and lge), small grain (grain and silage), and gn sorghum (grain and silage). Except small grain crops, savings of $2-$3 per c were achieved by producers using -w rather than 4-row equipment.

These data permitted identification of "ore efficient producers" of cotton and bbeans. The more efficient utilizers of vilable resources were able to achieve ilar yields of cotton with from $13.01 $14.06 per acre less input costs than usual producer. Recent technological lelopments have shown that these effi-nt producers can reduce their costs by additional $2-$3 per acre and increase r yields by 5% when field operations seedbed preparation are reduced on ropriate soil types and in the absence ertain weed infestations.

The total specified costs per acre of production for the various crops with usual production practices on sandy soils for 4- and 6-row equipment, respectively, were: cotton (solid), $120.37 and $117.57; cotton (2 x 1 skip), $137.24 and $128.21; cotton (2 x 2 skip), $150.74 and $141.54; cotton (4 x 4 skip), $134.88 and $134.23; soybeans, $27.51 and $25.03; corn (grain), $82.65 and $80.72; corn (silage), $100.93 and $99.00.

Total per acre specified costs on clay soils with usual production practices for 4- and 6-row equipment, respectively were: solid cotton (spring seedbed preparation), $127.51 and $125.37; and soybeans $30.46 and $27.39.

Total specified costs per acre on sandy and clay soils with usual production practices for 4- and 6-row equipment, respectively, were: small grain (grain), $29.11 and $27.53; small grain (silage), $34.11 and $32.53, grain sorghum (grain), $45.73 and $43.70; and grain sorghum (silage), $52.83 and $50.83.

Days available for fieldwork in the Delta area of Mississippi by time periods based on weather records collected at Stoneville, Mississippi, average yields, materials prices, and tractor and equipment prices are also included.

Table 50. Estimated average number of days suitable for fieldwork on sandy soil, by months, Stoneville, Mississippi, 1931-1967 1/

Month	Estimated days suitable for fieldwork 2/	
	Tillage	Nontillage
January	3.1	7.3
February	6.5	10.3
March	14.3	17.8
April	18.6	20.6
May	21.3	22.6
June	20.2	21.2
July	24.6	25.1
August	24.0	25.0
September	23.6	24.8
October	13.9	17.2
November	6.4	10.0
December	2.8	6.2

1/ These estimates are upper limit values based on Stoneville weather data and computed using the techniques presented in D.A.E. Research Report No. 384, Department of Agricultural Economics and Agribusiness, Louisiana State University, Days Suitable for Fieldwork, Mississippi River Delta Cotton Area, November 1968.

2/ These estimates assume everyday as a potential workday, with no adjustment for Sundays and holidays. To make these adjustments multiply value by 0.86 for any month without a holiday and by 0.83 for any month with one holiday.

Table 51. Estimated average number of days suitable for fieldwork on clay soil, by months, Stoneville, Mississippi, 1931-1967 1/

Month	Estimated days suitable for fieldwork 2/	
	Tillage	Nontillage
January	1.5	3.1
February	3.9	5.7
March	8.6	12.1
April	14.8	17.3
May	19.5	21.2
June	19.8	20.8
July	24.6	25.1
August	24.5	25.1
September	23.6	24.3
October	13.7	16.2
November	4.2	7.1
December	1.2	2.7

1/ These estimates are upper limit values based on Stoneville weather data and computed using the techniques presented in D.A.E. Research Report No. 384, Department of Agricultural Economics and Agribusiness Louisiana State University, Days Suitable for Fieldwork, Mississippi River Delta Cotton Area, November 1968.

2/ These estimates assume everyday as a potential workday, with no adjustment for Sundays and holidays. To make these adjustments multiply value by 0.86 for any month without a holiday and by 0.83 for any month with one holiday.

Table 52. Estimated days suitable for fieldwork on sandy soil by specified 15 day periods, Stoneville, Mississippi, 1931-1967 1/

Period	Estimated number of days 2/	
	Tillage	Nontillage
March 15 - March 29	7.6	9.1
March 30 - April 13	8.0	9.4
April 10 - April 28	9.8	10.7
April 29 - May 13	10.6	11.2
May 14 - May 28	10.2	10.9
May 29 - June 12	10.3	10.9
June 13 - July 27	9.8	10.2
June 28 - July 12	11.5	11.9
July 13 - July 27	11.8	12.1
July 28 - August 11	11.7	12.1
August 12 - August 26	11.6	12.1
August 27 - September 10	11.9	12.4
September 11 - September 25	12.1	12.7
September 26 - October 10	9.1	10.3
October 11 - October 25	6.6	8.0
October 26 - November 9	4.7	6.8
November 10 - November 24	2.6	4.3
November 25 - December 9	1.9	3.3

1/ These estimates are upper limit values based on Stoneville weather data and computed using the techniques presented in D.A.E. Research Report No. 384, Department of Agricultural Economics and Agribusiness, Louisiana State University, Days Suitable for Fieldwork, Mississippi River Delta Cotton Area, November 1968.

2/ No adjustment has been made for Sundays and Holidays.

Table 53. Estimated days suitable for fieldwork on clay soil by specified 15 day periods, Stoneville, Mississippi, 1931-1967 1/

Period	Estimated number of days 2/	
	Tillage	Nontilla
March 15 - March 29	4.7	6.4
March 30 - April 13	5.7	7.2
April 14 - April 28	8.3	9.3
April 29 - May 13	9.4	10.3
May 14 - May 28	9.5	10.3
May 29 - June 12	10.1	10.7
June 13 - June 27	9.7	10.1
June 28 - July 12	11.2	11.7
July 13 - July 27	12.1	12.2
July 28 - August 11	12.0	12.1
August 12 - August 26	11.7	12.1
August 27 - September 10	11.8	12.2
September 11 - September 25	12.3	12.5
September 26 - October 10	9.1	10.0
October 11 - October 25	6.5	7.8
October 26 - November 9	3.6	5.4
November 10 - November 24	1.8	2.7
November 25 - December 9	1.0	2.1

1/ These estimates are upper limit values based on Stoneville weather data and computed using the techniques presented in D.A.E. Researc Report No. 384, Department of Agricultural Economics and Agribusir Louisiana State University, Days Suitable for Fieldwork, Mississip River Delta Cotton Area, November 1968.

2/ No adjustment has been made for Sundays and holidays.

Table 54. Estimated days suitable for fieldwork on sandy soil during specified periods, Stoneville, Mississippi, 1931-1967 1/

Period	Estimated number of days 2/	
	Tillage	Nontillage
March 16 - April 20	19.8	22.9
April 21 - May 20	20.3	21.6
May 21 - June 20	21.4	22.6
November 15 - March 1	15.2	28.7
November 15 - April 7	32.7	50.0
November 15 - May 7	52.9	71.8

1/ These estimates are upper limit values based on Stoneville weather data and computed using the techniques presented in D.A.E. Research Report No. 384, Department of Agricultural Economics and Agribusines Louisiana State University, Days Suitable for Fieldwork, Mississippi River Delta Cotton Area, November 1968.

2/ Adjustment for Sundays and holidays varies from 0.86 to 0.83 of valu shown.

'able 55. Estimated days suitable for fieldwork on clay soil during specified periods, Stoneville, Mississippi, 1931-1967 1/

Period	Estimated number of days 2/	
	Tillage	Nontillage
larch 16 - April 20	14.1	17.6
pril 21 - May 20	17.6	19.5
lay 21 - June 20	20.9	22.1
ovember 15 - March 1	8.1	14.1
ovember 15 - April 7	18.6	28.8
ovember 15 - May 7	35.5	47.9

/ These estimates are upper limit values based on Stoneville weather data and computed using the techniques presented in D.A.E. Research Report No. 384, Department of Agricultural Economics and Agribusiness, Louisiana State University, Days Suitable for Fieldwork, Mississippi River Delta Cotton Area, November 1968.

/ Adjustment for Sundays and holidays varies from 0.86 to 0.83 of value shown.

T le 56. Estimated days suitable for field work on sandy soils by combination of month, Stoneville, Mississippi, 1931-1967 1/

Period	Estimated number of days 2/	
	Tillage	Nontillage
Juary - March	23.9	35.4
F ruary - April	39.4	48.7
M ch - May	54.3	61.0
A il - June	60.1	64.4
J - July	66.1	68.9
J e - August	68.8	71.3
J y - September	72.2	74.9
A ust - October	61.5	66.9
S tember - November	44.0	52.0
O ober - December	23.0	33.5
D ember - January	12.6	23.8
D ember - February	26.6	23.8
D ember - March	12.5	41.4

These estimates are upper limit values based on Stoneville weather data and computed using the techniques presented in D.A.E. Research Report No. 384, Department of Agricultural Economics and Agribusiness, Louisiana State University, Days Suitable for Fieldwork, Mississippi River Delta Cotton Area, November 1968.

Adjust for Sundays and holidays by multiplying values shown by 0.86, 0.85, 0.84, and 0.83 for periods with no holidays and one to three holidays respectively.

Table 57. Estimated days suitable for fieldwork on clay soils by combination of months, Stoneville, Mississippi, 1931-1967 1/

Period	Estimated number of days 2/	
	Tillage	Nontillag
January - March	14.0	20.9
February - April	27.4	35.1
March - May	43.0	50.5
April - June	54.1	59.2
May - July	63.9	67.2
June - August	68.9	71.0
July - September	72.7	74.5
August - October	61.7	65.6
September - November	41.5	47.6
October - December	18.9	26.0
November - January	6.9	13.0
December - February	6.5	11.3
December - March	14.9	23.2

1/ These estimates are upper limit values based on Stoneville weather data and computed using the techniques presented in D.A.E. Research Report No. 384, Department of Agricultural Economics and Agribusines Louisiana State University, Days Suitable for Fieldwork, Mississippi River Delta Cotton Area, November 1968.

2/ Adjust for Sundays and holidays by multiplying values shown by 0.86, 0.85, 0.84, and 0.83 for periods with no holidays and one to three holidays respectively.

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he Technology of Production and Processing Sweet Potatoes in Mississippi

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The Technology of Production and Processing Sweet Potatoes in Mississippi

(H. L. Hammett and G. R. Ammerman, MAFES Horticulturists)

INTRODUCTION

he information presented in this bulletin generated by the Sweet Potato Collabora- Group which originated in 1938 and is now l the National Sweet Potato Cooperators erence.

he group was organized by Julian C. Miller e Louisiana Agricultural Experiment Sta- W. S. Anderson of the Mississippi Agricul- and Forestry Experiment Station, and ge B. Hoffman of the United States De- nent of Agriculture Horticultural Field Sta- at Meridian, Mississippi (Anderson 1959). he Mississippi data presented in this bulle- esulted from work done by the authors. averages for all stations are from data pro- ll by the various cooperators and complied Dr. Travis P. Hernandez, Secretary of the ional Sweet Potato Collaborators nandez, 1967, 1968, 1969, 1970, and).

he sweet potato (Ipomoea batatas (Lam.) been used by man for food for many years. is not been accurately determined where weet potato originated. It is of tropical or opical origin, probably originating in Cen- or Tropical America or the West Indies.

he crop has spread to tropical, subtropical, warmer temperate areas throughout the d. It is very well adapted to the climatic itions existing in large areas of the South- United States, and today is one of the most rtant vegetable crops in the area, both in ge and in monetary value.

The sweet potato is one of Mississippi's lead- vegetable crops. About 10,000 acres were ted to the crop in 1971. The crop can be n throughout the state; however, the hern one-fourth of the state grows very few t potatoes because of problems with the t potato weevil. The largest area of produc- is in Chickasaw and Calhoun Counties in h Central Mississippi.

The sweet potato industry in the Southeast- tates was built around the Porto Rico culti- which was introduced into Florida from to Rico in 1908. The Unit I Porto Rico was sed by Dr. Julian Miller of the Louisiana cultural Experiment Station as an improved ty of the late 1930's. This mutation from original Porto Rico became widely distrib- throughout the South.

Of the cultivars available to growers in the 1930's, none had good resistance to the r diseases of the crop. The National Sweet to Collaborator's Conference made the first rt toward developing an intensive breeding ram to develop disease-resistant varieties. e the organization of this group, some 45 ties have been developed, named and re- ed to growers; however, many of these are onger grown.

The sweet potato is a long-season annual, t varieties requiring a growing season of 100 to 150 days for most profitable yields. The crop produces reasonably well on all but the heaviest of Mississippi soils; however, best yields of high quality roots are obtained on sandy, well-drained soils.

The soil should be broken deeply in the spring, well pulverized, and put up in rows about 12 inches in height. Width between rows will vary depending upon equipment available to the grower to handle the crop. Generally, 38- to 40-inch row crop equipment is used for most cultural practices.

Due in no small measure to the efforts of the Sweet Potato Cooperators, the average yield in hundred weights per acre increased from 60 in 1950-59 to 102 in 1970. However, the acreage harvested in the United States went down from about 320,000 acres to 137,600 acres, and total production dropped about 20 percent during the same period (Table 1).

The value of the sweet potato crop is about 61 million dollars annually for the United States and about 3.3 million dollars annually for Mississippi (Table 2). The value per acre harvested in Mississippi has gone from $393 in 1964 to $442 in 1969. These values are over three times the dollar value of production per harvested acre for any other row crop reported in Mississippi, with the exception of Irish potatoes and cotton (Table 3). The dollar value per acre harvested is obviously closely related to the yields. At a price of $44 per ton, the value per acre would be $352 for the fairly easily attained yield of 8 tons per acre and $440 per acre for the good yield of 10 tons per acre (Table 4). It is not unusual for some growers to make excellent yields of up to 12 tons per acre.

The per capita consumption of sweet potatoes in the United States has declined from about 29.3 pounds in 1919 to 5.9 pounds in 1966. During this time, consumption of canned sweet potato roots has increased from nothing in 1919 to 1.1 pounds in 1966 (Table 5).

In 1960, sweet potatoes were not packed as a frozen food, but by 1965 there was an annual pack of 9.4 million pounds of frozen sweet potatoes (Table 6). Unfortunately, the increase in consumption of processed sweet potatoes has not offset the reduction in consumption of fresh roots; so, the net effect has been a reduction in per capita consumption to less than one-fourth of the 1919 level.

The reduction in consumption of the sweet potato is unfortunate in view of the fact that it is an attractive, tasty and nutritious food. One hundred grams of baked sweet potato contains the following average amounts of:

Calories	*125*
Protein	*1.8 grams*
Fat	*0.7 grams*
Ash	*1.1 grams*
Carbohydrate	*27.9 grams*
Crude fiber	*1.0 grams*
Calcium	*30.0 milligrams*
Phosphorus	*49.0 milligrams*
Copper	*0.15 milligrams*
Vitamin A	*7700 international units*
Vitamin B[1]	*0.10 milligrams*
Vitamin B[2]	*0.06 milligrams*
Nicotinic acid	*0.7 milligrams*
Water	*68.5 percent*

A medium sized baked root weighs about 162 grams. A physically active man needs about 5000 internation units of vitamin A daily, so one medium sized sweet potato would provide well over the daily requirement of this vitamin.

Processed sweet potatoes offer good profit opportunities where production and processing is efficiently carried out. The direct cost involved in canning a case of 24 No. 303 roots is about $2.17 (Table 7).

Prices received for whole canned sweet potatoes ranged from $4.00 to $6.50 per case of 24 No. 303's in 1969-70 and for cut potatoes from $3.60 to $4.65 (Table 8). Obviously there are items of other than direct cost such as investment, depreciation, sales and advertising, utilities, and taxes (Ammerman **et. al.,** 1968). However, the growth in processing suggests strongly that a profit can be made from processing sweet potatoes.

The most popular items among the many can sizes and several styles are the 24 No. 303, 24 No. 3, and the 24 No. 2½ syrup packs. In 1969 about 2.1 million cases of 24 No. 2½'s and about 2.O million cases of 24 No. 3's were packed. For the same year the pack of all can sizes was 8.1 million cases of syrup pack, 627 thousand cases of vacuum pack, and 234 thousand cases of solid pack (Tables 9 and 10).

Materials and Methods for Production

Variety tests were conducted at State College, the North Mississippi Branch Station at Holly Springs and on two soil types at the Pontotoc Ridge-Flatwoods Branch Station. Fertilizer tests were grown at the North Mississippi Branch Station at Holly Springs and on the J. R. Pennick farm near Vardaman, Mississippi.

The variety test plots consisted of two rows, 40 inches wide and 30 feet long, replicated four times with replicates separated by 4 ft. alleys.

The fertilizer tests were three-row plots, 30 ft. long, replicated four times with yield data collected only from the center row of each plot. The cultivar "Centennial" was used throughout the fertilizer tests. The appropriate fertilizer was applied and the rows were bedded on the fertilizer.

All plots were planted during May each year. Uniform transplants of the appropriate

cultivar were selected and set in the field using a Powell 1-row transplanter with an automatic watering attachment which applied ½-pint of water around the roots of each transplant. Weeds were controlled with a uniform broadcast application of Di-phenamid at five pounds per acre.

The plots were harvested in late September and early October each year. The roots were "plowed-out" and separated into the different grades, based on size and shape, and weighed. The grades used were No. 1, Canner's, and Total marketable. Specifications were:

Grade	Diameter	Length
No. 1	1 3/4 to 3 1/2 inches	5 to 10 inches
Canner's	1 to 1 3/4 inches	3 to 7 inches

Total marketable included No. 1's, Canner's, and oversize roots that were sound and smooth. Yields were expressed in number of 55-pound bushels per acre.

Immediately after harvest, a ½-bushel sample of canning-size roots of each variety was delivered to the processing laboratory for processing tests. The No. 1 roots were carried to the curing room and cured five to six days at 85°F and approximately 85 to 90% relative humidity. The temperature was then reduced to 55°F and the humidity was held at about 80% for the duration of the storage period.

After 30 days of storage, uniform size roots of each cultivar were selected, washed, baked and evaluated for baking quality.

Plant Production

Plant production was studied in 1969, 1970, and 1971 at State College, Mississippi. One bushel of roots of each entry was bedded in builder's sand in an electrically-heated, thermostatically-controlled, glass-sash-covered hotbed. The roots bedded ranged from 1 3/4 to 2 1/2 inches in diameter and 5 to 9 inches in length. On bright sunny days it was necessary to open the sash to maintain the temperature in the 70-95°F range.

Water was applied as necessary to maintain favorable moisture conditions. As the sprouts reached transplanting size – 8 to 12 inches – they were removed, counted and transplanted to the field.

Materials and Methods for Processing

Canned roots were processed within 24 hours of harvest. They were washed, then immersed in 10% sodium hydroxide (lye) solution at boiling temperature for 3 to 6 minutes. The peel was washed off and the roots trimmed and submerged in fresh water.

They were put into No. 303 or 2½ size, enamel-lined cans, and covered with 25% sucrose solution at the boiling temperature for the location. The cans were exhausted to 180°F and quickly closed. The cans were processed according to National Canners Association recommendations, cooled to 90 to 110°F and stored at 70 to 80°F until evaluated (Anon. 1966).

For the baking test, the roots were dug and cured for five to six days at 85°F with a relative humidity of 90%. The roots were stored at 55°F until baked for evaluation. The oven was brought to 350°F, the roots were placed in the preheated oven and baked 1½ hours or until they were soft. Nine roots of each variety in the range of 2¼ to 2½ inches in diameter were baked and evaluated.

Scoring of canned roots has been on the basis of the following maximum scores for the indicated quality attribute:

Chromaticity (color intensity)	10
Uniformity	15
Attractiveness	15
Smoothness	10
Moisture	10
Lack of fiber (freedom from fiber)	15
Favor	25
Weighted score	100

Baked samples were scored by expert panels for intensity of color, uniformity of color, flavor and attractiveness. The weighted score was determined. Scoring of baked roots has been on the basis of 1 to 10 with 1 representing poor and 10 excellent roots.

Color was evaluated in terms of the Hunter Color and Color Difference Meter using the orange tile having color attributes of "L" = 58.4, "b" = 31.4, and "a" = 27.7.

Fiber was measured by placing a representative 100-gram sample of mascerated canned sweet potato on a previously weighed 30-mesh monel metal screen. The sweet potato was washed with a spray of tap water until fibrous material free of pulp was retained on the screen. The screen and sample was dried for two hours at 100°C, cooled in a desiccator and weighed rapidly. The weight of the screen was deducted and results reported as milligrams of fiber per 100 grams of root.

Firmness was measured in terms of Asco firmness meter values (Figure 1). The root was placed in the Asco meter belt using a preload of 250 milligrams and a test load of 1,000 milligrams in the X2 position with a timing of five seconds. It is important that root diameter be kept as constant as possible for this evaluation.

For shear values the Model PP-1 Texturepress was used (Figure 2). Samples weighing 150 grams were placed in the shear cell, as pieces of root arranged lengthwise across the test cell grid. Results were reported in pounds of force to shear the sample.

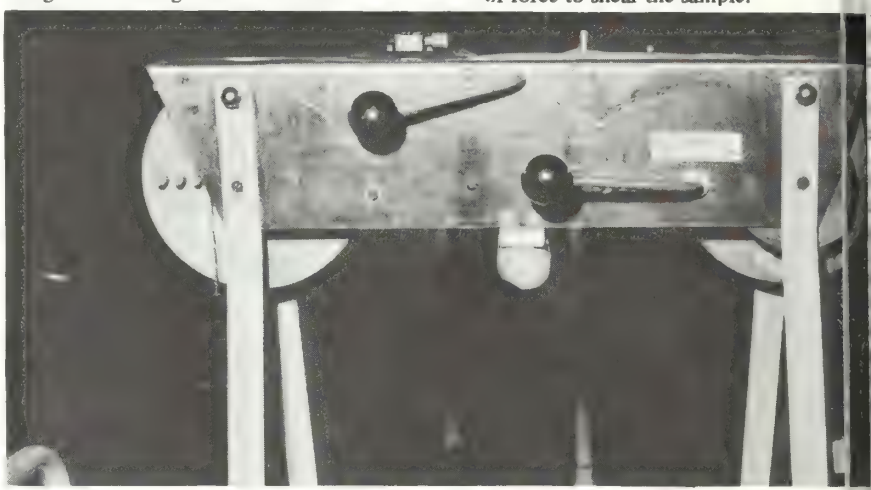

Figure 1. The Asco Firmness meter used for determining sweet potato firmness.

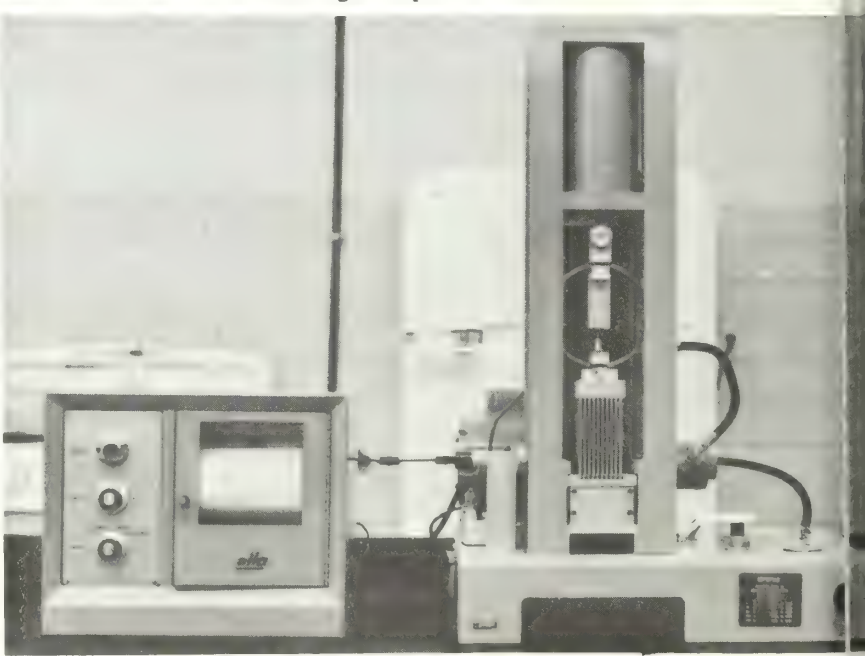

Figure 2. The Model PP-1 Texturepress Allo Kramer type shearpress equipped with a Model TR-1 Texturecorder.

PRODUCTION:
ults and Discussion

elatively large number of varieties of potatoes have become available to the in recent years. In addition to the d varieties, many growers have their own n of certain types. Only the standard s recommended for Mississippi will be ed here.

ntennial' is a fresh market and processing t is the leading variety now grown in the The roots are variably tapered to cylindri- medium-to-large; have a copper-colored deep orange flesh and excellent eating . The vines are vigorous, thick, and trail- ne leaves are large, entire, and quickly he soil after setting in the field.

ntennial is a heavy-yielding variety that well. It is a moderate producer of sprouts pagation in the spring and has moderate ce to stem rot and internal cork. It is tible to black rot, scurf, soil rot, and root ematodes.

se Centennial' is a variety very similar to 'Centennial' except that it has a rose- d skin. Yields are generally somewhat than 'Centennial'.

m' is a high-yielding variety grown pri- for fresh market, but is also suitable for sing. Roots are blocky, relatively uniform n attractive copper-tan skin and orange Vines are vigorous but the foliage is rela- thin. Gem is a good plant producer in the gation bed and has good resistance to ot, but is susceptible to the other com- ests. It tends to crack severely when ex- to the air at harvest time.

oldrush' is a variety for fresh market and sing. Roots are tapered spindle, uniform, ttractive, with a copper-orange skin and an flesh. The vines are short to medium and moderately vigorous. This variety is y producer of plants in the propagation It has excellent resistance to stem rot; but eptible to black rot, scurf, soil rot, inter- rk and other sweet potato pests. This vari- s been virtually replaced by 'Centennial'.

vel' is a good fresh market and processing y. Roots are somewhat blocky, uniform, h and attractive with a copper skin show- slight rose "blush". The vines tend toward g and foliage is not dense. It is a reason- good plant producer (comparable to 'Cen- l') and has good stem rot resistance, but rack under certain environmental condi-

lian' is a fresh market and processing vari- at was developed primarily for processing ses. The roots are smooth, tapered, spin- aped with a dark copper skin. It has a deep orange flesh with an unusually high ne content. It makes a heavy set of roots large proportion of them are in the small edium canning size. The vines are vigor- with moderately heavy foliage density. ll yields have only been moderate. It is ered by being a poor plant producer, and t is more difficult to propagate. It is resis- o stem rot and appears resistant to inter- ork. It is susceptible to the other sweet o pests.

nit I Porto Rico' is a fresh market and ssing type that has been grown primarily esh market. One of the older varieties, it o resistance to the common field diseases. roots are variable, spindle to globular in shape, and irregular. The skin is smooth, light copper in color. The flesh color is orange-yellow to salmon with gradation from the root to the stem end, being much lighter in color at the root end. It is excellent in quality as a baked root. The vines are medium to long, trailing, with fairly dense foliage. The plant is moderate in yield of roots.

Except for 'Unit I Porto Rico', all of the above described varieties have been grown in yield tests in Mississippi and throughout the Southeast for several years. Tables 11, 12, and 13 present yield data of selected varieties over a two to five year span. Also included are three breeder's lines which have shown considerable promise. In yield of Number 1 roots 'Centennial' is as good as any tested and is perhaps more consistent than some. 'Jewel', a North Carolina variety, yields well; however, there is a strong tendency to crack at harvest, and it does not appear to hold up as well in storage. In yield of canning grade roots (Table 12) 'Jewel' is more erratic than 'Centennial', but over a five year span, its average yield exceeded that of 'Centennial'. From a total marketable yield standpoint, none of the tested varieties or breeder's lines were appreciably superior to 'Centennial' on a regional basis. There are differences in such things as disease resistance and storage qualities which must be considered.

Table 14 presents yield data for a five year period (1964-68) for five varieties at four locations in Mississippi. These yield data are not greatly different from those presented in Table 13. 'Unit I Porto Rico' is not widely grown due to its lack of disease resistance. 'Goldrush' is somewhat inferior in yielding ability when compared to 'Centennial'; however, it probably has a measure of disease resistance superior to any other available variety. No one variety is best at all locations over all years; however, when yields are averaged for all locations, the relative yielding ability of a variety becomes apparent. However, in selecting a sweet potato variety, factors other than yield must be considered. The variety must be one the local market will accept. When production is intended for processing, the variety selected must be one that the processor will buy.

Plant Production

Data presented in Table 15 indicate the sprout production potential for six varieties and three breeding lines at State College, Mississippi. Data are the averages for two and three "pullings" per season for three years. As indicated by the data, there is substantial variation among varieties in their transplant production potential. The amount of seed stock that will be required to produce an adequate number of plants to set the desired acreage is dependent on the variety and on how much of the acreage is to be planted at any one time. The amount of seed stock to bed to obtain a sufficient number of plants for an acre will depend upon the variety. A good guide is 8 to 10 bushels of roots for each acre, assuming two or three pullings from the bed.

In any crop, one of the primary keys to a good yield of a good quality crop is the seed stock. The sweet potato is no exception, as it mutates readily and careful selection must be exercised in the field at harvest and at bedding time to assure plants that are as free of mutation as possible. A foundation seed program was developed in Mississippi in the early 1960's and was located at the Pontotoc Ridge – Flatwoods Branch Station. The purpose of this program is to help the grower maintain a good stock of seed roots that are true to the variety. To insure that his seed stock is of this type, the grower should go back to certified or foundation seed at least every three to four years.

If the grower plans to produce his transplants, he must decide on some type of bed, bedding media, and supplemental heat source. Any of several types of plant beds will produce satisfactory plants for transplanting to the field.

Some growers bed their seed stock in the open field. Open field beds produce plants in about 10 to 12 weeks after bedding. This is the most inexpensive method of bedding for the grower who does not wish to plant early. It should be noted that this type of bed has fewer pullings than other types, and hence, would require an increase in the seed stock that is bedded. Since the seed stock is placed in open field beds, soil temperature at night should not be lower than 55°F because of increased danger of the seed stock being destroyed by soil organisms.

Cold frames, covered with glass sash, plastic or canvas, will produce suitable transplants in 8 to 10 weeks. Since this type bed has some protection from the environment, although no supplemental heat is supplied, roots could be bedded several days earlier than in the open field beds.

Hotbeds, plant growing beds provided with a source of supplemental heat, are also widely used in growing sweet potato transplants. The use of heated beds enables the grower to bed earlier and have transplants ready as soon as field conditions are favorable for the crop. The use of heated beds is especially important where the grower is aiming for the early fresh market. Both electrically and flue heated hotbeds are satifactory. The electrically heated beds utilize soil cables controlled by a thermostat and are the most reliable. Flue heated beds depend on radiation or connection of heat from the flues of a combustion chamber in which some type of fuel – usually wood – is burned. Hot water circulated through pipes in the bed may also be used. Manure was at one time widely used as a heat generator for hotbeds. It has several major disadvantages, especially with sweet potatoes: (1) disease problems related to its use, (2) reliability, and (3) availability. Manure heated beds have been cited on numerous instances as the source of scurf infection. Manure heated beds depend on the activity of soil microorganisms to release the heat energy. The organisms are much less active at lower temperatures, hence the colder the surrounding soil area becomes, the less heat that is available. Electric soil cables are the most reliable and easiest to use source of supplemental heat. Figures 4, 5 and 6 illustrate some of the steps in "bedding" in an electrically heated hotbed. The heating cables must be spaced uniformly through the bed and spaced six to eight inches apart, Figure 4. The cables should be checked to insure that they are heating properly. They are then covered with 1 to 1½ inches of sand or bedding soil. Figure 5 shows placement of roots in the bed. They should be placed in such a manner that no two roots touch. After the roots are placed in the bed, they are then covered with 3 to 4 inches of sand or other bedding material, Figure 6, watered thoroughly, and covered. The beds must be watched carefully and ventilated as needed to prevent the temperature from reaching harmful levels. A temperature in the range of 80 to 85°F should be

maintained in the hotbed. Roots should be bedded six to eight weeks before the plants are

The grower should use the type of bed that will yield quality plants at the time he will need them. Hotbeds will produce the greatest number of plants in the shortest period of time. Plans for hotbeds and cold frames and detailed information on their management may be obtained through your local county agent.

Several materials are used as bedding media for sweet potatoes. Some of the more commonly used ones are (1) sawdust, (2) sand, and (3) soil. If soil is used, it should be of a sandy type and should come from an area on which sweet potatoes have not been grown. Sawdust that is well rotted may be used but disease development, especially scurf, is more likely. Sterile sand is probably one of the best bedding medias for sweet potatoes. Regardless of the material used, it should not be used more than once.

Only disease free roots should be bedded. Roots which are 1¼ to 2 inches in diameter will produce the largest number of vigorous plants. Smaller roots will tend to produce smaller plants, and larger roots will produce fewer plants per bushel but larger plants.

Transplanting

The sweet potato requires a long growing season with relatively warm nights for optimum growing conditions. In general, the longer the season the higher the yeild; however, the growing conditions. In general, the longer the season the higher the yield; however, the frost has passed. Good, strong transplants produce the best yield. The plants should be set in the field as soon after pulling from the bed as possible. Only healthy transplants should be used. The transplants should be set with at least three nodes (joints) below the soil level. A uniform plant spacing throughout the field is essential if a good yield of uniform roots is to be expected.

Sweet potatoes are set in the field either by hand or with mechanical transplanters. Transplanting by hand is a relatively slow process, requires much labor and is usually confined to planting small areas. Large acreages generally use mechanical transplanters – either single or multiple row machines. Mechanical transplanters will help insure a more uniform spacing and depth of the transplants. Most mechanical transplanters have watering attachments which will water the plant roots as it is set in the field. This is a very desirable feature to insure good liveability of the transplants. The use of a starter solution such as 10-52-17 in the transplant water has proven to be a tremendous boost in getting the plants off to a good start. Three pounds of this material should be mixed in 50 gallons of water and applied at the rate of about one-half pint per plant.

If a sufficient number of plants are not obtained from the plant beds, the grower may increase his acreage through the use of vine cuttings. After the early plantings have become well-established and begin to produce vines, cuttings four to six nodes (joints) in length may be made and transplanted much as the original transplants. These must be watered to insure good rooting. The use of vine cuttings is also a good method of keeping diseases under control.

Fertilizers

Fertilizer recommendations for sweet potatoes should be based on soil tests. The crop grows and produces best on a soil with a pH of 5.8 to 6.4.

Table 16 presents five years of experimental data with sweet potato fertilizers at Vardaman and Holly Springs, Mississippi. From this work the ratio or relative amounts of these nutrient materials in relation to each other appears to be important. The amount of nitrogen should be low in relation to phosphorus and potassium, particularly potassium. High nitrogen rates tend to promote vine growth at the expense of root development. There is much conflicting data on root shape in relation to potassium and nitrogen-potassium ratios. Natural soil content of elemental potassium varies to such an extent that it would be extremely difficult to measure potassium effect on shape of the enlarged roots. The ratio of the elements to each other was important in this study.

In the absence of suitable soil test data a fertilizer supplying 20 to 40 pounds of nitrogen and 60 to 80 pounds of P_2O_5 and K_2O on a moderately fertile Mississippi soil will produce satisfactory yields.

Fertilizer should be applied in the bed prior to transplanting. It is normally applied at the time the beds are made – usually two weeks or so prior to transplanting.

Cultivation

The sweet potato field is normally prepared using the equipment available with rows from 38 to 44 inches apart. Subsequent cultivation will utilize the equipment available. Properly prepared beds are approximately 8 to 10 inches high after transplanting. Roots of the plants soon occupy most of the bed area. Cultivation should be only as is necessary to control weeds or to break hard crusts. Cultivation should be such that the roots in the bed are not injured. Disk hillers or other instruments of a similar nature which throw soil to the bed tend to avoid root damage. Bed height at the final cultivation should be 10 to 12 inches.

Chemical Weed Control

Good progress has been made in the development of chemicals to control weeds in sweet potatoes. Control of weeds in the early part of the season is generally all that is necessary because once the crop becomes established and the vines cover the soil surface, they will shade weeds and prevent them from becoming a problem later in the season. Most of the weed control chemicals are applied as post-transplant applications and growers are referred to the Mississippi Weed Control Handbook (Cole, **et. al.**, 1970) for the proper chemical to use and the procedure to follow.

Water Requirements and Irrigation

Sweet potatoes are commonly referred to as a drought resistant crop and they do show an excellent degree of drought tolerance. However, lack of adequate moisture is probably the principal limiting factor to sweet potato yields in Mississippi. There are few growing seasons in which the crop receives adequate moisture throughout the season. Periods of prolonged drought seriously retards plant growth and reduces yield. Supplementary irrigation ca used to advantage. Most years the m July and August are the most critical s moisture supply is concerned. Periods ture stress during the early part of t can also be important; however, the d reduce yield nearly so much as p drought during July and August. Nor early July, most plants have complete the vine growth and have begun to se age roots. Moisture stress at this time growth and development of these sto and may affect the shape of the ro moisture levels result in excessive vin and long roots. Wide variations in mois ply, especially during mid to late gro son causes excessive growth cracks on t During July and August the sweet pot should have the equivalent of about on moisture every 7 to 10 days. If natura does not supply this amount the pla receive supplementary irrigation to b moisture level up to this point for bes The method of water application is n portant as is the application of water it method that affords relatively uniform tion over the area is satisfactory. Mai of the soil moisture level at 20 to 50% capacity has resulted in as good yields moisture levels.

Harvesting

Most of the sweet potatoes grow in United States are harvested during late ber, October, and early November. Som early plantings in Mississippi may be in the last half of August when pric their best. Although the yield may be tially lower at that time, prices paid roots are usually enough higher to o lower yield.

Most of the early harvested roots directly on the fresh market without Harvest date will be influenced to som by planting date. Most sweet potato require a growing season of approxima days of warm weather for maximum Some of the earlier maturing varieties harvested in about 90 to 100 days; the longer the harvest is delayed the gr be the total yield. Delay of harvest increase the percentage of roots in the " category. The crop should be observed and harvested when it is determined adequate yield of number one roots able for maximum return. Harvest sh completed before soil temperatures fal 50°F. The later the harvest is delay greater is the possibility of damage fro sively wet soils and cold temperatures.

Several methods of harvesting swee toes are currently used in Mississip grower should choose the method that appropriate for his specific situation. acreages are normally plowed out with ing plow or middle "buster". Large such as those grown for processing or acreages for storage and subsequent sale fresh market are normally harvested wi chanical harvesters. Mechanical harveste in the state range from small one-row large four-row machines. The method of normally is governed largely by the acr be harvested. For example, it would be for a grower with one acre of sweet pota purchase a large four-row harvester. Re

method that is used, harvesting will be ted if the vines are removed from the ior to harvest.

sweet potatoes must be handled in a which keeps cuts, bruising and skinning nimum. The harvester must be operated proper depth and speed. Some field grad- uld be practiced at harvest in order to excessive handling and bruising later. harvested roots should not be left in ld and exposed to the sunshine or rain. with red Irish potatoes has shown that left in the field on a clear day can reach erature of 120°F on the surface in about ours, hence prolonged exposure to sun- hould be avoided. By the same token potatoes are injured by exposure to low atures, and harvested roots should not in the field overnight when the air tem- res are likely to drop below 50°F.

o of the more popular containers used in sweet potatoes are referred to as the s' Crate", a wooden wire bound crate olds approximately 55 pounds, and pallet Pallet boxes hold about 800 to 1000 s of freshly dug roots. The roots should ld graded and placed in the containers lly to prevent injury. The containers not be rounded up as stacking will cause to those potatoes exposed at the top. that are to be cured should be carried to orage room the same day they are har- .

Curing and Storage

e curing and storage facilities should pro- emperature and humidity control. Curing to heal injuries caused by harvesting, and zation occurs most rapidly at approxi- y 85°F with a relative humidity of 90 to The length of the curing period is deter- somewhat by weather conditions at har- If weather conditions are still warm as is the case in late September in Mississippi, oots can be cured in four to five days in ove conditions. However, if weather con- s have gotten noticeably cooler and soil eratures are in the 40's and lower 50's, should be six to eight days at 85°F and 95% relative humidity. Curing helps to ct the roots from damage by disease in e and from excessive shriveling while es are converted to sugars and other fla- mponents.

oots that are to be processed should not red, and they should be delivered to the ssing plant or pick-up station within 24 of harvest if at all possible. After curing been completed for the harvested roots, eratures in the storage area should be re- l to 55 to 60°F and humidity to 80 to Storage at the lower temperature will pro- the storage life. Sweet potatoes for fresh et should be washed, waxed and carefully d to meet the market requirements. This is ally done just prior to marketing the sweet oes. Care should be taken in grading and ging as many buyers will often pay a pre- for the more attractive roots. Potatoes in ticular carton should be relatively uniform e and shape. Care should be taken at all to prevent exposure of the sweet potato to temperatures below 50°F and pro- d exposures at this temperature must be ed.

Diseases of Sweet Potatoes and their Control

Stem rot: This disease is caused by the fusarium **Oxysporum f. batatas** [(Wr.) Snyd. and Hans.] and is probably the most important and most widely distributed disease of this crop. It is a field disease, the organism is soil borne and occurs in every state where sweet potatoes are grown. As much as 50% of the crop of susceptible varieties may be destroyed in severe infestations. The fungus can overwinter in the soil on remains of the dead sweet potato vines or on roots in storage. The disease may be carried from one field to another by insects, farm animals, farm implements, drainage water, and discarded diseased roots. In the field, the first indication of stem rot is a slight change in the appearance of the younger leaves. They become somewhat dull in color and then yellow between the veins. The vines wilt and eventually the entire plant collapses and dies. In plants where the disease is suspected, the plant stem can be split near the soil line, discoloration of the vascular tissue at this point is a sure indication of the disease.

The most important control measure is the use of resistant varieties. 'Goldrush' is virtually immune to the disease. The other newer varieties possess good field resistance. 'Unit I Porto Rico' has no resistance. Other important control measures are the use of disease free seed stock for plant production and growing the crop in rotation with other crops that are not attacked by the fungus. A three to five year rotation should be practiced.

Soil rot: Another field disease of the sweet potato is soil rot, also known as pox and ground rot. The disease is caused by **Streptomyces ipomoea** [(Person and W. J. Martin) Waksm. and Henrici] and is present in practically all sweet potato producing areas of the United States. Many of the lateral feeding roots or fiberous roots are destroyed and those that remain are often poorly formed. Nearly black flecks or spots of varying size and shapes occur on the roots and the decayed areas may girdle a given root. Often it is simply a spot on a side of the root, and continued growth around the spot gives the root a sunken appearance.

The fungus will not develop at a pH of 5.0 or lower. Some research results indicate that the application of sulphur to reduce the soil pH has met with limited success. The best control measures are the use of disease free seed, rotations of three to five years, and use of techniques which avoid spreading the organism from one field to the other with equipment.

Scurf: Another major disease of the crop is scurf caused by the fungus **Monilochaetes infuscans** (Ell. and Halst. et. Harter). It is widely distributed throughout the sweet potato growing areas. It is characterized by blackened spots or areas over the surface of the root which enlarge during storage. The interior portions of the roots do not appear to be affected in the earlier stages, but the storage life of the roots is shortened. The primary damage from the disease is the unattractive appearance of the roots.

Heat (122°F for 10 minutes) and fungicide treatments of the roots to be bedded have been reported to give good control. However, the two most effective control measures are three to five year crop rotation and the use of vine cuttings for transplanting.

Black rot: Black rot of sweet potatoes, although not as prevalent now as in the past, is still a serious disease. It is caused by the cause by the fungus **Ceratocystis fimbriata** (Ell. and Halst.). The organism is soil and/or seed borne. Some resistance to the organism has been reported; however, none of the current varieties are resistant to black rot. The black rot organism produces dark colored to nearly black sunken, somewhat circular spots on the surface of the sweet potatoes. At first the spots are small and almost round, but under favorable conditions, they enlarge and often cover the entire sweet potato. Sweet potatoes that are affected by black rot have a very disagreeable bitter taste when cooked. Roots become infected in the field and the disease continues to develop in the storage house. Roots may appear sound when stored, but become badly affected within a short period after storage.

Heat treatments (122°F for 10 minutes) and several chemicals have been tested for control and all give some but not complete control. Any treatment measure must be combined with a long-term rotation (four to five years) and satisfactory fumigation of the storage house.

A reliable fumigation procedure for the storage house involves the use of formaldehyde and potassium permanganate. For each 1000 cubic feet of space use 16 ounces (1 pint) of formaldehyde (40% formilin) and 23 ounces of potassium permanganate ($KMnO_4$). Place the two materials in an enameled or wooden vessel, stir well, and get out quickly. Close all openings and leave closed for 24 to 48 hours. Air the house thoroughly (48 hours) and then sweet potatoes may be placed in it.

The use of vine cuttings is an effective way of getting away from diseased transplants for growing in the field.

Internal cork: Internal cork is a virus disease that is widely distributed throughout the sweet potato growing areas of the United States and occurs with considerable frequency. External symptoms of the disease are difficult if not impossible to recognize. The characteristic symptom of internal cork is the presence of hard brown to black necrotic "corklike" lesions within the fleshy root tissue of the sweet potatoes. Aphids feeding on infected plants spread the virus to non-infected plants. The 'Centennial' variety appears to have some resistance to internal cork. The disease has not been reported in 'Julian' and some of the other newer varieties.

Controlling aphids would help prevent spread of the disease. The use of disease free seed is essential. Foundation seed stocks are screened regularly for internal cork, hence the use of foundation seed at periodic intervals would be an effective way of keeping the disease under control.

Soft rot: Soft rot is caused primarily by the fungus **Rhizophus nigricans** (Ehr.), but it may also be caused by at least eight other species of Rhizophus. Although it may develop in the field prior to harvest under wet conditions, it is primarily a storage rot. The fungus enters the sweet potato through wounds caused during harvest and invades the root tissue causing it to rot. Curing the roots at 85 to 90°F and at a humidity near 90% helps prevent the development of the organism.

Many growers treat the "seed stock" just prior to bedding as a precaution against seed-born diseases. The materials most commonly used are borax and Vancide 51. Either material

may be mixed with water to a concentration of 2% borax (or Vancide 51) and the sweet potatoes dipped in the solution for 10 minutes. The treated roots should be drained thoroughly and bedded immediately.

Chemical treatments of the roots during the washing operation in preparation for market has been an effective control measure in controlling the rots in the market channels.

The materials most commonly used are sodium-ortho-phenylphenate (SOPP) and 2,6-dichloro-4=nitroaniline (botran). Label instructions must be followed carefully.

PROCESSING

Color Intensity: 'Centennial' was used as the control variety and had an average color intensity score of 6.94 for the five years 1967 through 1971 for all cooperating stations (Table 17) (Figure 3). Although the Mississippi average was 5.78, 'Centennial' colored poorly in two of the five years with scores of 4.00 in 1969 and 4.60 in 1970. 'Julian' had the best average color intensity score in Mississippi with a five-year average of 9.60. The average for 'Julian' for all stations was among the highest with a value of 8.59. The only entry with a higher average for all stations was 'L7-177', a new 1971 entry from Louisiana. This entry had an average value for all stations and for Mississippi of 9.00. The new variety 'Redmar' also scored well in 1970 and 1971 at all stations, and in 1971 the only year it was evaluated in Mississippi.

It should be noted that there is a large year-to-year variation for the same variety grown in each of the five years, 1967 through 1971. The range in color intensity for 'Centennial' in terms of the average for all stations was 6.60 in 1970 to 7.41 in 1968, or a range of 0.81. However, the range for the five varieties reported by all stations in 1970 was much wider with from 6.10 for 'Goldrush' to 7.60 for 'Redmar', for a range of 1.50. The 1968 data shows a greater range due to different varieties (2.17).

Color Uniformity: 'Centennial' scored about the same in Mississippi (8.66) over the five years of evaluation and averaged 8.56 for all stations. However, in 1969 the Mississippi color uniformity score of 4.80 was substantially lower than the 7.06 average score for all stations. 'Julian', grown only in 1967 and 1968, had the best average color uniformity for all stations and in Mississippi. 'Redmar', with a Mississippi one-year score of 9.25, and 'L7-177', with a one-year score of 9.00, both look good in terms of color uniformity. The data indicates that 'Rose Centennial' was superior to 'Centennial' as regards color uniformity (Table 18).

Attractiveness: 'Julian' had the highest average score for all stations (10.49) and for Mississippi (11.50). 'Centennial' had a five-year average attractiveness score of 7.68 for all stations compared to 6.64 for Mississippi. 'Rose Centennial', 'Julian', 'Jewel', and 'L7-177', all scored higher than 'Centennial' in Mississippi for overall attractiveness (Table 19).

Wholeness: For the two years it was studied, 'Julian' scored highest for wholeness. The average for all stations was 10.74 and for Mississippi, it was 10.50. 'Rose Centennial', 'Julian', 'Jewel', 'Redmar', and 'L7-177', all scored higher than 'Centennial' for wholeness when grown and canned in Mississippi (Table 20).

Surface Smoothness: The average surface smoothness score for all stations in the years 1967 through 1971 was 6.75 for 'Centennial'. The average surface smoothness for this variety grown and canned in Mississippi was 6.40.

Figure 3. Canned Centennial sweet potatoes.

Flavor: The flavor scores for the varieties evaluated ranged from 7.00 to 7.68 in terms of the grand average for all stations and all years. The average flavor score for all stations and years for 'Centennial' was 7.45 and for Mississippi, it was 7.53. None of the named varieties or new entries appear to offer much chance of significantly improving the flavor of the product as presently canned (Table 22).

Weighted Score: 'Julian' was the highest scoring variety in the study of canned sweet potatoes in terms of the overall weighted score for all stations and for Mississippi. 'Redmar', with a score of 78.25, and 'Jewel', with 72.17, both outscored 'Centennial' with a Mississippi score of 68.04. The new entry 'L7-177' had a one-year weighted score of 86.50 in M and an all stations' average weighted 81.90. It is the variety which comes the canned quality of 'Julian', but m of data are necessary before we w whether or not it has horticultural ch tics which preclude naming and use (T

Baked Product

Color Intensity: The grand avera stations in the five years for baked 'Ce was 7.41 compared to 6.80 for baked nial' roots produced in Mississippi. 'F tennial', 'Julian', 'L7-177' and 'L7-1 superior to the control in terms of colo ty of the baked roots when we com average scores for all stations and yea sissippi average scores for all years. 'L7-177' scored highest in Mississip and in terms of the average for all (8.90). The two new entries in 'L7-177' and 'L7-182', both scored w the control 'Centennial' and 'Julian' (T

Color Uniformity: The overall aver uniformity score for 'Centennial' was all stations compared to 6.88 for M 'Rose Centennial', 'Julian', 'Jewel', and 'L7-182', all scored well above th in terms of the overall average for al and years. In terms of the grand avera sissippi, 'Rose Centennial', 'Julian', 'L7-177', and 'L7-182', were superio tennial'. However, only 'Centennial' an were grown and evaluated all five yea 25). Color scores for both canned a roots of 'Centennial' grown in Missi 1969 were unusually low. This is canned color intensity (Table 17), can uniformity (Table 18), baked color (Table 24) and baked color uniformi 25). These low values for a variety for out of five illustrate the danger involve ety evaluation studies of short duratio

Flavor: The grand average flavor 'Centennial' was 7.31 and for Mississi 'Centennial' continues to be the highe variety on baked flavor in terms of t average for all stations over all years. in Mississippi 'Rose Centennial', 'Jew 'L7-182' scored higher than 'Centen baked flavor. 'Goldrush' also scored ab tennial', but it was only evaluated on five years. The baked flavor score for 7- which has scored well for all other attr canned and baked quality was 6.47 c to 6.91 for 'Centennial' (Table 26).

Attractiveness: 'Jewel', 'Juli 'L7-177' outscored the 'Centennial' c terms of grand average attractiveness s Mississippi 'Rose Centennial', 'Julian' 'L7-177', and 'L7-182' all scored hig 'Centennial'.

The entry 'L7-177' scored very we 1970 and 1971, the two years it was in Mississippi. The average score for years for attractiveness in Mississippi compared to 6.45 for 'Centennial'. T 'L7-182' also scored 8.43 for attrac which is well above the average for 'Ce (Table 27).

Weighted Score: The grand average score for 'Centennial' was 72.28 for all and 65.69 for Mississippi. In terms of t average weighted scores for all 'L7-177' was the highest with a score It scored higher than 'Julian' which ha

70 'Jewel' with 72.73. The highest grand e weighted score for Mississippi produced was 83.50 for 'L7-182'. In Mississippi '7' with an overall average score of 77.93, ıar' with 69.22 and 'Jewel' with 67.09, higher than 'Centennial' in terms of ted total score (Table 28).

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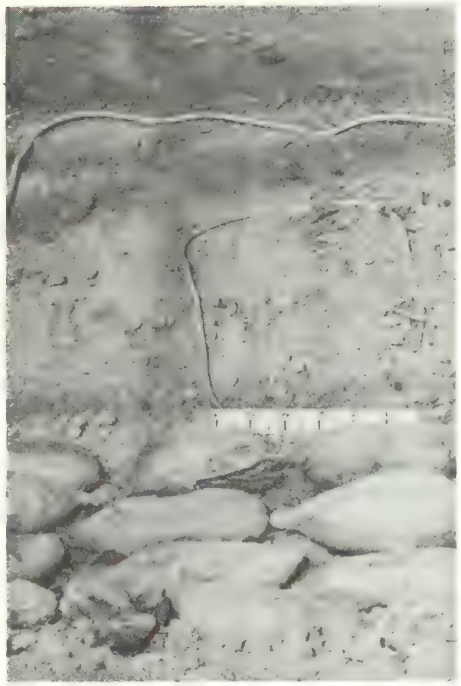

Figure 4. Heating cables should be uniformly spaced 6 to 8 inches apart in the bed.

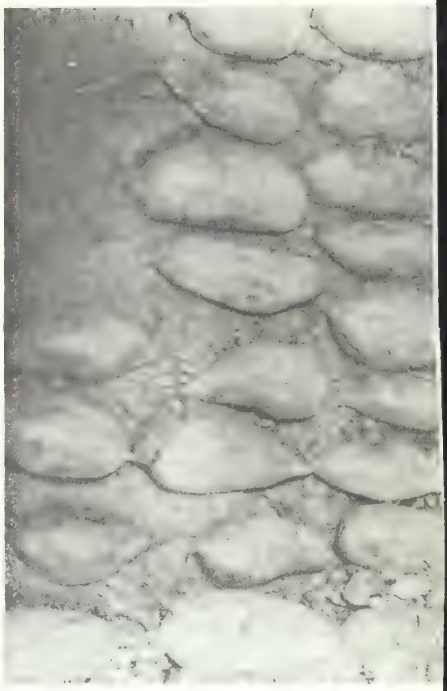

Figure 5. The roots should be evenly spread the bed with no piling and preferably with N 2 roots touching.

Figure 6. After placing the roots in the bed, cover with approximately 3-4 inches of sand or other bedding material, water thoroughly a cover the bed.

Table 1. Sweet potato acreage, yield, and production in the United States from 1950 through 1970.

Item	YEARS							
	1950-59	1964	1965	1966	1967	1968	1969	1970
Total harvested 1000 acres	320.1	182.6	206.2	186.6	146.6	149.0	145.6	137.6
Average yield per acre (CWT)	60	84	91	88	93	92	101	102
Production 1000 CWT	18,898	15,265	18,748	16,331	13,658	13,763	14,654	14,086

From Anon. (1971)

Table 2. Cash receipts to farmers from sweet potatoes in Mississippi, 1959-1969 in thousands of dollars.

YEARS										
1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
2,555	3,281	1,998	2,157	2,317	2,614	4,648	4,807	4,296	4,060	3,342

From Converse, et. al. (1970)

Table 3. The dollar value of sweet potato production per harvested acre in Mississippi compared to the other selected crops, for the years 1964 through 1969.

	CROP						
Year	Sweet Potatoes	Irish Potatoes	Cotton Lint	Alfalfa	Soybeans for Beans	Corn for Grain	Wheat
1964	393.00	364.70	223.26	49.45	50.92	47.88	37.99
1965	461.55	405.00	196.90	51.24	55.80	49.78	35.48
1966	434.35	204.00	142.16	81.25	65.33	52.92	53.72
1967	428.40	292.50	160.91	77.30	59.22	53.34	43.20
1968	442.00	285.00	181.50	63.52	66.15	47.58	31.05
1969	442.00	280.00	120.15	70.40	52.80	42.16	35.65

From Converse, et. al. (1970)

Table 4. The dollar value per acre of sweet potatoes in Mississippi as affected by tons per acre yields.

Yields in tons per acre	Price per unit ($/ton)	Value in dollars per acre
6	44	264
8	44	352
10	44	440

Table 5. The pounds per capita total consumption of sweet potatoes compared to canned sweet potatoes for the years 1909 through 1966 in the United States.

	YEARS						
Product	1909	1919	1929	1939	1949	1959	1966
Sweet potatoes total	26.2	29.3	22.6	19.8	12.3	8.7	5.9
Canned sweet potatoes	-	-	0.2	0.1	0.5	1.2	1.1

From Ammerman and Edmond (1971)

Table 6. The frozen sweet potatoes processed annually in the United States for the years indicated.

Product	YEARS					
	1960	1961	1962	1963	1964	1965
	1000's of pounds per year					
Frozen sweet potatoes		8,027	9,934	7,986	12,333	9,353

From Ammerman and Edmond (1971)

Table 7. Sweet potatoes: materials required and direct cost per case of 24 No. 303 canned sweet potatoes, sample canning plant, Mississippi, 1972.

Item	Quantity per Case
Materials required:	
Raw produce at 70 cases per ton	26.6 lb.
Salt	0.2 lb.
Cans and lids, No. 303	24.0 each
Shipping case	1.0 each
Labels	24.0 each
Shipping weight per case	31.0 lb.
Direct cost per case:	
Produce cost at $44/ton	$0.627
Sugar	0.250
Cans and lids	0.900
Shipping case	0.085
Direct labor	0.219
Administrative cost and overhead labor	0.076
Employee benefits	0.010
Total direct cost	$2.167

From Ammerman and Edmond (1971) adjusted for price changes.

Table 8. Price per case of 24 No. 303 canned sweet potatoes, F.O.B. the processing plant, for the dates and styles indicated in terms of dollars in the United States.

Style	DATES					
	Nov. 4 1970	Sept. 19 1970	July 25 1970	Aug. 29 1970	Mar. 26 1970	Nov. 12 1969
Whole	4.20	6.50	6.50	6.50	5.50	4.00
Cuts	3.60	4.65	4.65	4.65	3.80	3.75

From Ammerman and Edmond (1971)

Table 9. The canned sweet potato pack by size of container in 1000's of actual cases, in the United States.

Container Size	YEARS									
	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
48/8 oz.	212	368	341	271	390	310	126	266	282	257
24/2 Vac.	-	83	121	211	205	99	202	352	221	272
24/303 & 300	762	1230	1581	1336	1041	1799	1314	1220	1649	1555
24/3	1600	1691	2311	1894	1564	2121	1891	1957	1917	2006
24/2½	968	1164	1576	1078	1060	1612	1266	1277	1471	2054
12/3 Cyl.	236	267	227	204	239	207	371	150	163	200
16/10	896	925	1414	1163	1023	1404	1411	1287	1447	1635
Misc.	163	109	129	163	123	440	625	694	789	1003

From Anon. (1971)

Table 10. Canned sweet potatoes by style of pack in 1000's of actual cases for the indicated years in the United States.

Style	YEARS									
	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Solid pack	112	135	157	146	111	159	202	192	247	234
Syrup pack	3801	4931	6317	5207	4691	7004	6060	6149	6957	8122
Vacuum pack	925	770	1226	967	843	967	943	863	735	627

From Almanac (1971)

Table 11. Average yield of selected sweet potato varieties and seedlings in 55-pound bushels per acre grown throughout the Southeastern United States and in Mississippi.

Variety	NO. 1 MARKETABLE YIELDS											
	1967		1968		1969		1970		1971		Grand Avg. All Stations	Grand Avg. Miss.
	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.		
Centennial	264.53	268.00	252.59	248.00	275.78	184.00	298.00	170.00	189.00	273.00	255.98	228.60
Rose Centennial	314.14	249.00	270.22	289.00	294.33	-	275.00	-	107.50	-	252.24	269.00
Goldrush	222.00	212.00	208.50	-	243.67	-	-	-	156.33	-	207.63	212.00
Julian	201.89	267.00	199.40	250.00	131.00**	-	67.00**	-	22.50*	-	124.36	258.50
Redcliff	305.50*	-	461.00	-	442.00*	-	-	-	-	-	402.83	-
Nemagold	288.00*	-	320.67	-	205.00**	-	264.00**	-	-	-	269.42	-
Jewel	322.37	239.00	345.37	415.00	297.68	192.00	310.00	110.00	298.00	278.00	314.68	246.80
Redmar	-	-	-	-	-	-	232.00	98.00	235.80	180.00	233.90	139.00
L7-177	-	-	-	-	-	-	273.00	157.00	258.00	305.00	265.50	231.00
L7-182	-	-	-	-	-	-	276.00	93.00	275.00	239.00	275.50	166.00
L4-73	-	-	284.53	290.00	313.78	197.00	290.00	138.00	260.00	221.00	287.08	211.50

* Avg. of two stations
** One station reported

Table 12. Average yield of selected sweet potato varieties and seedlings in 55-pound bushels per acre grown throughout the Southeastern United States and in Mississippi.

COMMERCIAL CANNING YIELDS

Variety	1967		1968		1969		1970		1971		Grand	Grand
	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.
Centennial	64.94	58.00	66.94	46.00	83.94	45.00	102.00	27.00	112.00	190.00	85.96	73.20
Rose Centennial	63.21	53.00	76.00	48.00	136.00	-	145.66	-	104.50*	_	105.07	50.50
Goldrush	62.00	-	68.38	-	34.00**	-	-	-	101.31	-	66.42	-
Julian	149.27	161.00	108.40	137.00	151.00**	-	195.00**	-	167.50	-	154.23	149.00
Redcliff	59.50*	-	90.67	-	82.00*	-	-	-	-	-	77.39	-
Nemagold	115.00*	-	77.33	-	54.00**	-	211.00**	-	-	-	114.33	-
Jewel	322.37	239.00	54.68	69.00	77.59	47.00	88.00	17.00	109.00	182.00	130.32	110.80
Redmar	-	-	-	-	-	-	152.00	39.00	163.00	148.00	157.50	93.50
L7-177	-	-	-	-	-	-	86.00	28.00	134.00	197.00	110.00	112.50
L7-182	-	-	-	-	-	-	77.00	17.00	102.00	133.00	89.50	75.00
L4-73	-	-	65.93	84.00	78.38	47.00	104.00	26.00	147.00	149.00	98.84	76.50

* Avg. of two stations
** One station reported

Table 13. Average yield of selected sweet potato varieties and seedlings in 55-pound bushels per acre grown throughout the Southeastern United States and in Mississippi.

TOTAL MARKETABLE YIELDS

Variety	1967		1968		1969		1970		1971		Grand	Grand
	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.
Centennial	378.12	341.00	359.24	361.00	415.89	289.00	470.00	228.00	452.00	491.00	415.05	342.00
Rose Centennial	463.07	372.00	420.11	416.00	416.33	-	493.66	-	235.00*	-	405.63	394.00
Goldrush	311.50	284.00	296.88	-	371.00*	-	-	-	238.50*	-	304.47	284.00
Julian	370.50	427.00	318.20	387.00	283.00**	-	271.00**	-	193.50*	-	287.24	407.00
Redcliff	367.50*	-	561.00	-	534.50*	-	-	-	-	-	487.67	-
Nemagold	438.50*	-	414.33	-	266.00	-	496.00**	-	-	-	404.21	-
Jewel	423.05	291.00	446.32	574.00	441.05	317.00	472.00	177.00	458.00	511.00	448.08	374.00
Redmar	-	-	-	-	-	-	398.00	137.00	394.00	352.00	396.00	244.50
L7-177	-	-	-	-	-	-	408.00	203.00	414.00	578.00	411.00	390.50
L7-182	-	-	-	-	-	-	454.00	114.00	414.00	509.00	434.00	311.50
L4-73	-	-	400.27	442.00	485.17	303.00	488.00	204.00	474.00	430.00	456.86	444.5

* Avg. of two stations
** One station reported

Table 14. Average yield of marketable roots (55 lb. bu./acre) of five varieties of sweet potatoes at four locations in Mississippi over a five-year period.

Variety	Holly Springs	Pontotoc Ridge	Pontotoc Flatwoods	State College	Average
Centennial	341	415	350	321	357
Goldrush	266	335	295	265	290
Gem	278	442	328	354	350
Julian	209	370	324	277	295
Unit I Puerto Rico	256	343	260	262	280

Table 15. Sprout production per bushel of bedded roots of selected sweet potato varieties at State College, Mississippi for the year 1971.

Variety	Number sprouts per bushel	
	2 pullings	3 pullings
Centennial	1450	1825
Rose Centennial	1117	1395
Goldrush	1985	2360
Julian	1123	1406
Jewel	1728	2096
Redmar	2035	2450
L7-177	1220	1740
L7-182	1390	1811
L4-73	1622	1943

Table 16. The effect of rate of fertilization on yield of marketable* roots (55 lb. bu./acre) of Centennial sweet potatoes at selected locations in Mississippi.

Fertilizer	YEAR						
$N-P_2O_5-K_2O$	1958	1959	1960	1961	1962	Avg.**	
20-30-30	312	331	315	244	208	282	bc
60	306	295	-	-	-	300	b
90	312	343	290	217	213	275	c
20-60-30	285	312	-	-	-	299	b
60	330	334	368	318	210	312	a
90	311	322	260	263	234	278	c
20-90-30	274	284	-	-	-	279	c
60	256	285	-	-	-	271	c
90	288	281	-	-	-	285	b
40-30-30	282	189	230	280	210	238	d
60	281	302	249	304	236	274	c
90	301	290	-	-	-	296	b
40-60-30	272	296	-	-	-	284	b
60	322	312	-	-	-	317	a
90	291	295	-	-	-	293	b
40-90-30	261	319	-	-	-	290	b
60	290	313	-	-	-	302	ab
90	325	342	379	301	261	322	a
60-30-30	285	302	-	-	-	294	b
60	259	349	-	-	-	304	ab
90	311	345	283	293	249	296	b
60-60-30	268	330	-	-	-	299	b
60	311	324	-	-	-	318	a
90	313	312	-	-	-	313	a
60-90-30	318	356	271	260	246	290	b
60	326	350	270	271	252	294	b
90	321	311	304	320	270	305	ab
None			182	227	186	198	e

* Marketable includes No. 1 and canning grades.
** Means followed by same letter not different.

Table 17. The color intensity for 8 varieties or selections of canned sweet potatoes evaluated by the National Sweet Potato Cooperators Group for 1967 through 1971. A score of 10 indicates excellent color intensity.

CANNED COLOR INTENSITY FOR THE INDICATED YEARS												
Variety	1967		1968		1969		1970		1971		Grand	Grand
	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.
Centennial	6.65	8.20	7.41	5.60	6.76	4.00	6.60	4.60	7.30	6.50	6.94	5.78
Rose Centennial	6.57	5.80	7.38	8.80	-	-	6.70	-	-	-	6.88	7.30
Goldrush	-	-	6.68	-	-	-	6.10	-	-	-	6.39	-
Julian	8.32	9.60	8.85	9.60	-	-	-	-	-	-	8.59	9.60
Jewel	7.07	-	7.07	8.80	7.55	7.50	6.50	5.80	6.80	6.00	7.12	7.03
Redmar	-	-	-	-	-	-	7.60	-	8.80	9.50	8.20	9.50
L7-177	-	-	-	-	-	-	-	-	9.00	9.00	9.00	9.00
L7-182	-	-	-	-	-	-	-	-	6.00	5.50	6.00	5.50

Table 18. Color uniformity for 8 varieties or selections of canned sweet potatoes evaluated by the National Sweet Potato Collaborators Group for the years 1967 through 1971. The larger scores indicate the most satisfactory uniformity.

COLOR UNIFORMITY - CANNED												
Variety	1967		1968		1969		1970		1971		Grand	Grand
	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.
Centennial	11.11	13.20	9.82	10.60	7.06	4.80	7.20	7.20	7.60	7.50	8.56	8.66
Rose Centennial	10.90	9.00	11.52	12.80	-	-	6.90	-	-	-	9.77	10.90
Goldrush	-	-	7.80	-	-	-	7.10	-	-	-	7.45	-
Julian	12.24	13.80	12.90	13.20	-	-	-	-	-	-	12.57	13.50
Jewel	12.48	-	11.86	13.80	8.06	8.00	6.60	5.80	7.20	6.00	9.24	8.40
Redmar	-	-	-	-	-	-	7.50	-	8.20	9.25	7.85	9.25
L7-177	-	-	-	-	-	-	8.70	-	9.10	9.00	8.90	9.00
L7-182	-	-	-	-	-	-	7.30	-	7.10	5.50	7.20	5.50

Table 19. The attractiveness for 8 varieties or selections of canned sweet potatoes evaluated by the National Sweet Poato Collaborators Group for the years 1967 through 1971. The larger scores indicate the most attractive product.

ATTRACTIVENESS - CANNED												
Variety	1967		1968		1969		1970		1971		Grand	Grand
	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.
Centennial	7.20	8.20	10.68	10.00	6.50	3.70	6.70	4.80	7.30	6.50	7.68	6.64
Rose Centennial	6.84	4.80	10.78	12.00	-	-	6.30	-	-	-	7.97	8.40
Goldrush	-	-	11.45	-	-	-	6.70	-	-	-	9.08	-
Julian	8.02	9.40	12.95	13.60	-	-	-	-	-	-	10.49	11.50
Jewel	7.70	-	11.44	13.40	7.89	8.20	6.80	6.80	6.80	3.75	8.13	8.04
Redmar	-	-	-	-	-	-	7.30	-	7.60	5.75	7.45	5.75
L7-177	-	-	-	-	-	-	8.70	-	8.90	9.75	8.80	9.75
L7-182	-	-	-	-	-	-	-	-	6.40	5.50	6.40	5.50

Table 20. The wholeness for 8 varieties or selections of canned sweet potatoes evaluated by the National Sweet Potato Collaborators Group for the years 1967 through 1971. The larger scores indicate the best degree of wholeness.

WHOLENESS - CANNED												
	1967		1968		1969		1970		1971		Grand	Grand
Variety	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.
Centennial	8.10	8.40	12.22	11.40	7.98	7.80	7.60	6.80	8.40	6.50	8.86	8.18
Rose Centennial	8.12	7.20	10.80	9.60	-	-	7.10	-	-	-	8.67	8.40
Goldrush	-	-	13.13	-	-	-	8.50	-	-	-	10.82	-
Julian	8.32	8.20	13.15	12.80	-	-	-	-	-	-	10.74	10.50
Jewel	8.48	-	12.21	10.20	8.80	8.50	7.90	7.20	8.60	7.50	9.20	8.35
Redmar	-	-	-	-	-	-	8.40	-	8.20	9.00	8.30	9.00
L7-177	-	-	-	-	-	-	9.20	-	9.00	9.25	9.10	9.25
L7-182	-	-	-	-	-	-	-	-	8.00	7.50	8.00	7.50

Table 21. The surface smoothness for 8 varieties or selections of canned sweet potatoes evaluated by the National Sweet Potato Collaborators Group for the years 1967 through 1971. The highest scores indicate the most satisfactory smoothness.

SURFACE SMOOTHNESS - CANNED												
	1967		1968		1969		1970		1971		Grand	Grand
Variety	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.
Centennial	3.90	4.80	7.70	7.80	7.33	6.70	7.20	6.20	7.60	6.50	6.75	6.40
Rose Centennial	3.56	1.80	7.00	7.40	-	-	8.00	-	-	-	6.19	4.60
Goldrush	-	-	7.35	-	-	-	7.20	-	-	-	7.28	-
Julian	3.76	4.00	8.60	8.00	-	-	-	-	-	-	6.18	6.00
Jewel	4.09	-	7.27	7.40	7.65	7.80	7.40	8.80	7.60	7.25	6.80	7.81
Redmar	-	-	-	-	-	-	7.40	-	7.40	8.25	7.40	8.25
L7-177	-	-	-	-	-	-	8.10	-	8.40	8.50	8.25	8.50
L7-182	-	-	-	-	-	-	-	-	7.10	6.75	7.10	6.75

Table 22. The flavor for 8 varieties or selections of canned sweet potatoes evaluated by the National Sweet Potato Collaborators Group for the years 1967 through 1971. The larger scores indicate the best flavor.

FLAVOR - CANNED												
	1967		1968		1969		1970		1971		Grand	Grand
Variety	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.
Centennial	7.82	10.00	7.43	6.40	7.20	6.80	7.20	7.20	7.60	7.25	7.45	7.53
Rose Centennial	7.33	8.00	7.43	8.20	-	-	7.00	-	-	-	7.25	8.10
Goldrush	-	-	7.70	-	-	-	7.50	-	-	-	7.60	-
Julian	7.60	8.50	7.75	7.60	-	-	-	-	-	-	7.68	8.05
Jewel	7.86	-	7.09	8.20	7.24	8.00	7.00	7.20	7.50	7.75	7.34	7.79
Redmar	-	-	-	-	-	-	7.30	-	7.30	6.75	7.30	6.75
L7-177	-	-	-	-	-	-	7.10	-	7.50	7.75	7.30	7.75
L7-182	-	-	-	-	-	-	-	-	7.00	7.25	7.00	7.25

Table 23. The weighted average score for 8 varieties or selections of canned sweet potatoes evaluated by the National Sweet Potato Collaborators Group for the years 1967 through 1971. A score of 100 would indicate a perfect product.

WEIGHTED SCORE - CANNED												
	1967		1968		1969		1970		1971		Grand	Grand
Variety	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.
Centennial	76.71	81.40	79.82	-	72.25	58.00	72.50	63.00	76.30	69.75	75.52	68.04
Rose Centennial	74.07	58.10	74.42	-	-	-	75.30	-	-	-	74.60	58.10
Goldrush	-	-	80.30	-	-	-	75.10	-	-	-	77.70	-
Julian	79.94	88.60	84.90*	-	-	-	-	-	-	-	82.42	88.60
Jewel	81.98	-	77.75	-	77.99	77.50	72.90	71.00	74.40	68.00	77.00	72.17
Redmar	-	-	-	-	-	-	75.00	-	76.00	78.25	75.50	78.25
L7-177	-	-	-	-	-	-	81.00	-	82.80	86.50	81.90	86.50
L7-182	-	-	-	-	-	-	-	-	70.60	68.75	70.60	68.75

* One station reported

Table 24. The color intensity for 10 varieties or selections of baked sweet potatoes evaluated by the National Sweet Potato Collaborators Group for the years 1967 through 1971. A score of 10 indicates excellent color.

BAKED - COLOR INTENSITY FOR INDICATED YEARS												
	1967		1968		1969		1970		1971		Grand	Grand
Variety	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.
Centennial	7.52	7.10	7.05**	7.00	7.03	4.50	7.70	6.50	7.40	8.90	7.41	6.80
Rose Centennial	8.28	7.10	7.15**	8.00	-	-	-	-	-	-	8.28	7.55
Goldrush	6.41	6.40	7.20*	-	-	-	-	-	-	-	6.41	6.40
Julian	8.39	7.90	-	7.60	-	-	-	-	-	-	8.39	7.75
Redcliff	3.20	-	-	5.20	-	-	-	-	-	-	3.20	5.20
Nemagold	5.60*	-	5.20*	-	-	-	-	-	-	-	5.60	-
Jewel	6.11	6.00	7.50**	7.20	7.50	6.50	7.40	6.66	6.90	7.10	6.98	6.69
Redmar	-	-	-	-	7.30*	-	7.50	6.50	6.60	8.40	7.13	7.45
L7-177	-	-	-	-	-	-	-	-	8.90	9.60	8.90	9.60
L7-182	-	-	-	-	-	-	-	-	7.50	8.20	7.50	8.20

* One station reported
** Average of two stations

Table 25. The color uniformity for 9 varieties or selections of baked sweet potatoes evaluated by the National Sweet Potato Collaborators Group for the years 1967 through 1971. A score of 10 would indicate excellent color uniformity.

COLOR UNIFORMITY - BAKED												
	1967		1968		1969		1970		1971		Grand	Grand
Variety	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.
Centennial	6.69	7.60	7.35*	8.40	5.84	4.00	6.90	6.50	6.60	7.90	6.68	6.88
Rose Centennial	6.98	7.20	6.95*	8.60	-	-	-	-	-	-	6.97	7.90
Goldrush	5.89	6.00	-	-	-	-	-	-	-	-	5.89	6.00
Julian	7.78	7.90	-	8.60	-	-	-	-	-	-	7.78	8.25
Redcliff	3.80	-	-	4.80	-	-	-	-	-	-	3.80	4.80
Jewel	6.91	5.80	8.05*	8.20	6.82	6.10	7.40	8.00	7.20	8.80	7.28	7.38
Redmar	-	-	-	-	-	-	-	5.66	6.60	7.10	6.60	6.38
L7-177	-	-	-	-	-	-	-	7.66	8.00	9.20	8.00	8.43
L7-182	-	-	-	-	-	-	-	8.50	7.40	8.60	7.40	8.55

* Average of two stations

Table 26. The flavor for 9 varieties or selections of baked sweet potatoes evaluated by the National Sweet Potato Collaborators Group for the years 1967 through 1971. A score of 10 would indicate excellent flavor.

FLAVOR - BAKED												
	1967		1968		1969		1970		1971		Grand	Grand
Variety	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.
Centennial	7.39	7.70	7.05*	7.60	6.92	4.60	7.60	6.66	7.60	8.00	7.31	6.91
Rose Centennial	7.16	6.90	7.40*	8.00	-	-	-	-	-	-	7.28	7.45
Goldrush	6.60	7.90	-	-	-	-	-	-	-	-	6.60	7.90
Julian	6.71	6.30	-	6.40	-	-	-	-	-	-	6.56	6.30
Redcliff	4.55	-	-	5.80	-	-	-	-	-	-	4.55	5.80
Jewel	7.07	6.00	7.65*	7.80	7.00	6.10	7.00	7.16	7.30	8.10	7.20	7.03
Redmar	-	-	-	-	-	-	-	6.50	7.30	6.90	7.30	6.70
L7-177	-	-	-	-	-	-	-	5.83	6.70	7.10	6.70	6.47
L7-182	-	-	-	-	-	-	-	7.83	7.20	7.60	7.20	7.72

* Average of two stations

Table 27. The attractiveness for 8 varieties or selections of baked sweet potatoes evaluated by the National Sweet Potato Collaborators Group for the years 1967 through 1971. A score of 10 would indicate the most attractive product.

ATTRACTIVENESS - BAKED												
	1967		1968		1969		1970		1971		Grand	Grand
Variety	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.
Centennial	7.04	7.30	6.90*	7.60	6.33	4.00	7.10	5.66	9.00	7.70	7.27	6.45
Rose Centennial	7.27	6.90	6.50*	7.80	-	-	-	-	-	-	6.89	7.35
Julian	7.94	8.10	-	7.40	-	-	-	-	-	-	7.94	7.75
Redcliff	3.10	-	-	5.20	-	-	-	-	-	-	3.10	5.20
Jewel	6.87	5.40	7.90*	7.80	7.48	6.60	7.60	7.16	7.40	7.80	7.45	7.15
Redmar	-	-	-	-	-	-	-	6.00	5.30	6.40	5.30	6.20
L7-177	-	-	-	-	-	-	-	8.16	8.00	8.80	8.00	8.48
L7-182	-	-	-	-	-	-	-	9.16	6.90	7.70	6.90	8.43

* Average of two stations

Table 28. The grand average weighted score for all factors of quality for baked sweet potatoes, 1967 through 1971. A score of 100 would indicate an excellent quality baked product.

WEIGHTED SCORE - BAKED												
	1967		1968		1969		1970		1971		Grand	Grand
Variety	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.	Avg. All Stations	Avg. Miss.
Centennial	74.60	52.60	71.50*	77.40	65.42	50.00	75.10	65.83	74.80	82.60	72.28	65.69
Rose Centennial	76.50	50.70	72.20*	78.60	-	-	-	-	-	-	74.35	64.65
Goldrush	66.70	50.10	71.00**	-	-	-	-	-	-	-	68.85	50.10
Julian	75.70	52.40	-	70.30	-	-	-	-	-	-	75.70	61.35
Redcliff	44.00	-	-	57.70	-	-	-	-	-	-	44.00	57.70
Jewel	-	44.30	73.60*	70.50	70.10	64.20	-	73.96	74.50	82.50	72.73	67.09
Redmar	-	-	-	-	-	-	-	65.63	68.50	72.80	68.50	69.22
L7-177	-	-	-	-	-	-	-	71.46	78.10	84.40	78.10	77.93
L7-182	-	-	-	-	-	-	-	84.60	73.50	82.40	73.50	83.50

* Average of two stations
** One station reported

8

1973

Bulletin 796

lan-Power Requirements or Continuous orestry Inventory (CFI)

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MAN-POWER REQUIREMENTS FOR CONTINUOUS FOREST INVENTORY (CFI)

By
James E. Moak
MAFES FORESTER

Bulletin No. 796

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Mississippi State University
September 1973

3/ Where clover disappears in the grass-clover mixtures apply 50 lbs. N in the fall.

ABSTRACT

During the establishment of a Continuous Forest Inventory system on the Mississippi ;tate University School Forest where a total of 324 circular plots 1/5 acre in size were ;talled, a time study was made on 212 of the plots. Three different crew organizations ·re used. Crew A, where two men made one trip to the plot; Crew B, where two men :ated and laid out the plot and three men returned later to make and record the easurements; and Crew C, where three men made two trips to the plot.

The weighted average of field time requirements, including travel time, was 7.42 an-hours per plot. It took 3.5 man-hours per plot for travel and off plot activities, and 93 man-hours per plot making the within plot measurements. The number of trees easured per plot was the most important factor determining time requirements within e plot. Crews A and B were equally efficient in number of trees measured per man-hour hile crew C was significantly slower.

Prediction equations for time requirements within the plot were developed for all ree crew organizations. Under existing conditions the organization of crew B, where vo men make the first trip to the plot followed by three men on a second trip seemed to ive some advantages. Man-hour requirements for within the plot activities for crew B ould be estimated if number of trees to be measured on the plot and the sum of their ameters were known.

3/ Where clover disappears in the grass-clover mixtures apply 60 lbs. N in the fall.

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IAN-POWER REQUIREMENTS FOR CONTINUOUS FOREST INVENTORY (CFI)

INTRODUCTION

Continuous Forest Inventory or CFI s been used as a management tool by rest managers for over 30 years in the nited States and for about 20 years in e South. And in 1965[1] it was estimated at there were over 130,000 permanent ots being maintained on approximately 5 million acres in this country. Stott de-ribes CFI as a proportional sampling stem based upon circular plots within hich all living trees above a specified b.h. are measured, described, recorded n punch cards or tape, machine com-led, and analyzed in whatever segre-ations of the data are needed.[2] Recent evelopments since this definition by tott have led to widespread use of vari-ble radius plots.

During the field installation of a CFI ystem on the Mississippi State University chool Forest, a time study was made to etermine man-hour requirements for var-ous activities involved in locating and es-ablishing the plots.

PROCEDURE

The field establishment plan called for ne systematic location of two one-fifth cre circular plots within each 40-acre ompartment. Essentially the plot layout epresents a line plot grid with the lines paced 20 chains apart and the plots paced 10 chains apart along the line.

There are approximately 8 thousand

[1]Reported by Shain in 1965, "CFI in Ameri-an Forest Management," Quarterly Bulletin, Vol. 47, No. 3, Michigan State Agric. Expt. Sta.

[2]Stott, Calvin B. 1968. "A short history of ontinuous forest inventory east of the Missis-ippi." Jour. For. Vol. 66, No. 11.

Figure 1. Driving a metal stake which designates the center of the permanent plot.

Figure 2. Measuring the tree heights with a Haga Altimeter.

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Figure 3. Establishing the plot radius with a 100 foot tape.

Figure 4. Numbering the tree with paint

a es in the School Forest, but due to s ne open spaces and irregularities the t al number of plots established was 4. These were permanently marked th a center stake which was witnessed two trees where possible. All live trees thin the plot 4-1/2 inches d.b.h. and ger were numbered, tagged, measured, d the data recorded on mark sense ds.

The time study covered 212 sample ots in 128 different 40 acre mpartments, 8 timber types, 4 density sses, 4 site classes, and a range in trees easured on an individual plot from 0 to . The sample also included three differ- t crews. Crew A, with two men making e trip to the plot had 28 observations; ew B, with two men locating and laying t the plot and three men returning to ish the measuring had 125 observa- ns; and crew C, with 3 men taking two ps to the plot had 59 observations.

Distance traveled by pickup to the ots ranged from 10 to 18 miles, with an average of 14 miles. On 53 of the sample plots the researcher traveled with the crew and recorded the time for 7 distinct activities with a stop watch to the nearest 1/100 of a minute for everything except travel time which was recorded to the nearest minute. For the other 159 plots, the tallyman on the crew recorded the time for five distinct activities to the nearest minute. Data on a sub-sample of 22 plots were recorded by the researcher who did nothing but record the time on 10 distinct activities.

DISCUSSION OF RESULTS

Table 1 gives the number of plots and man-hours required for establishment by three different crew organizations. As shown in the table, crew C, the three-man crew making two trips to each plot spent significantly more man-hours per plot; however, this was due primarily to higher man-hour travel time. While off the plot time was only 34 percent of the total for crew A, it was 50 percent for crew C.

ble 1. Man-hour requirements for CFI plot establishment by three different methods on the MSU School Forest.

Crew and Method	No. of Plots	Man-hours per plot		
		Total Time	Within Plot	Off Plot
A - 2 men, one trip	28	7.81	5.11	2.70
B - 2 men first trip, 3 men second trip	125	6.42	3.33	3.09
C - 3 men, two trips	59	9.37	4.64	4.73
Total Plots	212			
Weighted Average		7.43	3.93	3.50

3/ Where clover disappears in the grass-clover mixtures apply 60 lbs. N in the fall.

Early in the study it was apparent, as one would suspect, that the number of trees which were measured on the plot had a significant effect on the time required for plot establishment. Therefore, a more meaningful comparison of the crews can be made by allowing for a difference in the number of trees measured on the plot.

Crew efficiency within the plot can be compared by the number of trees that were measured per man-hour. Table 2 shows a comparison on this basis. Here we find that crew B was the most efficient in terms of actual work performed. Statistically crew B was 19.6 percent more efficient at the .05 level of confidence than crew C, but not significantly more efficient than crew A. Neither was crew A significantly more efficient than crew C.

Off Plot Activities

Many specific tasks were performed while the crews were establishing the plots. Table 3 gives the mean time spent in each of the off plot activities.

A rather high percentage of the off plot time was taken up in driving from the campus to the forest, 44 percent. This was an average of about one and one-half man-hours per plot established. Travel was along improved roads and the average distance was 14 miles one way.

The compartmental boundary lines in the forest had been previously brushed out and painted; therefore, the crews chained down these to the mid-point of the compartment and designated and marked a tree as a "point of beginning" or PB. They then proceeded by compass and chaining in a cardinal direction for five chains to the plot center.

It took less than half as long to chain 10 chains along the compartment boundary than it did to chain 5 chains into the interior of the compartment. This was possible because the compartmental boundaries were well marked and brushed out while it was necessary to run a compass line and, in most cases, cut brush going into the interior.

Table 2. Trees measured per plot and per man-hour within the plot for CFI plot establishment on the MSU School Forest.

Crew and Method	No. of Plots	Trees measured per plot	Trees measured per man-hour
A - 2 men, one trip	28	33.4	6.54
B - 2 men first trip, 3 men second trip	125	24.9	7.48
C - 3 men, two trips	59	26.3	5.67
Total Plots	212		
Weighted Average		26.4	6.72

Table 3. Man-hours required for off plot activities while establishing CFI plots on the MSU School Forest.

Task	No. Obs.	Average Man-hours per Plot	Percent of Total Off Plot Time
Driving to forest	55	1.54	44.10
Chaining from corner to PB[1]	51	0.16	4.48
Marking PB[2]	51	0.13	3.77
Chaining from PB to plot[3]	58	0.45	12.84
Mixed (overlapping, not separate)[4]	58	1.22	34.81
Total		3.50	100.00

1/ Chaining from compartment corner 10 chains to a suitable tree to be used as a PB.

2/ Marking a tree expected to remain several years with a large PB in paint and attaching a metal tag for identification purposes, to be used as a "point of beginning" from which to locate the plot for remeasurement.

3/ Chaining 5 chains in a cardinal direction inside the compartment to establish the center of the plot.

4/ Other activities such as gathering up instruments and tools, searching for the compartment corner, and other miscellaneous preparation prior to leaving the vehicle.

On Plot Activities

After locating each plot center many specific activities were necessary in completing the plot establishment. Many of these were distinct enough so that the time spent on each of them was recorded separately. Table 4 shows the time breakdown within the plot.

The most time-consuming activity (47 percent) was taking the height measurements of the trees. This involved four measurements on the sawtimber trees and three on the pulpwood size ones.

Measuring Tree Heights

During the measuring of tree heights a stop watch was used to obtain time for individual measurements. The job was divided into five operations. Distances from the base of the trees were measured with a 100' tape, then from these points the height measurements using the Haga Altimeter were made for (1) total height of the tree, (2) pulpwood height, (3) sawtimber height, and (4) height to live crown.

3/ Where clover disappears in the grass-clover mixtures apply 50 lbs. N in the fall.

Table 4. Man-hours required for within the plot activities while establishing CFI plots on the MSU School Forest.[1/]

Item	No. Obs.	No. Trees Measured on Plot (Average)	Average Man-hours per Plot	Percent of Tota within Plot Time
Witness Plot Center	54	27.2	0.43	10.92
Number Trees	22	35.0	0.14	3.48
Tag Trees	27	34.6	0.26	6.63
Measure d.b.h.	31	31.5	0.42	10.77
Measure Tree Heights	54	31.4	1.85	47.10
Mixed (overlapping)[2/]	23	---	0.83	21.10
Total			3.93	100.00

[1/] Two-man crew.

[2/] Miscellaneous jobs such as getting plot density, type, reproduc on count, mark 4-1/2 foot point on trees, determine site and size class, smooth trees for marking, and lost time.

Table 5 shows the average time in minutes required for one man to measure individual trees. The person measuring the trees decided which base distance to use. Generally 100 feet was used only if the trees were over 75 feet tall. As one would expect, it took longer to measure out 100 feet and 50 feet than it did either 30 feet or 25 feet. However, it took longer on the average to measure out 25 feet than for 30 feet. This was probably due to the use of 25 feet only in case of thick briars or undergrowth.

In this particular study these five measurements for tree heights were needed to meet detailed information requirements. Many firms who use CFI would not take all of these measurements.

Table 6 has been prepared to illustrate how one might use Table 5 data in this event. In using the Haga Altimeter, distance must be measured in order to ol tain total height. Therefore cumulati times are presented for distance plus ai additional measurements.

Figure 5 shows a comparison of tl time it took to measure the various heig components in pine type and in har wood types. All of the measuremen took significantly more time in hardwoc types than in pine types except for tot height (at the .05 level of significance).

One might suspect that this would l the case for the individual height me surements. It is not much harder to dete mine the top of hardwood trees than pi in order to sight with the Haga, but d ciding the point of merchantability hardwoods generally takes more \ tin than for pines. And also picking out th dead length or base of the live crow tends to be harder on hardwood tre than on pine.

Table 5. Average time for one man to take height measurements on individual trees with the Haga Altimeter on CFI plots.

Distance from tree in feet	Item	Measurement					Sum of all measurements
		Distance	Total Ht.	Pulpwood Ht.	Sawtimber Ht.	Ht. to Live Crown	
100	minutes	0.89	0.36	0.26	0.34	0.23	2.07
	no. obs.	54	54	52	39	47	
50	minutes	0.85	0.32	0.31	0.27	0.27	2.02
	no. obs.	764	764	589	207	640	
30	minutes	0.34	0.29	0.20	0.21	0.20	1.23
	no. obs.	352	352	293	34	332	
25	minutes	0.60	0.29	0.13	---	0.13	1.15
	no. obs.	59	59	6	---	29	
Weighted Avg. Minutes		0.70	0.31	0.27	0.28	0.24	1.79
Total Observations		1229	1229	940	280	1048	---

Table 6. Cumulative time to measure various height measurement components in measuring individual trees on CFI plots.

Item	Distance from Tree				Weighted Average
	100	50	30	25	
	---------- Minutes for one man ----------				
Distance	0.89	0.85	0.34	0.60	0.70
Distance plus total height	1.25	1.17	0.63	0.88	1.01
Distance plus total height plus pulpwood height	1.51	1.48	0.83	1.02	1.27
Distance plus total height plus pulpwood height plus sawtimber height	1.84	1.75	1.04	---	1.55
Distance plus total height plus pulpwood height plus sawtimber height plus height to live crown	2.07	2.02	1.23	1.15	1.79

3/ Where clover disappears in the grass-clover mixtures apply 80 lbs. N in the fall.

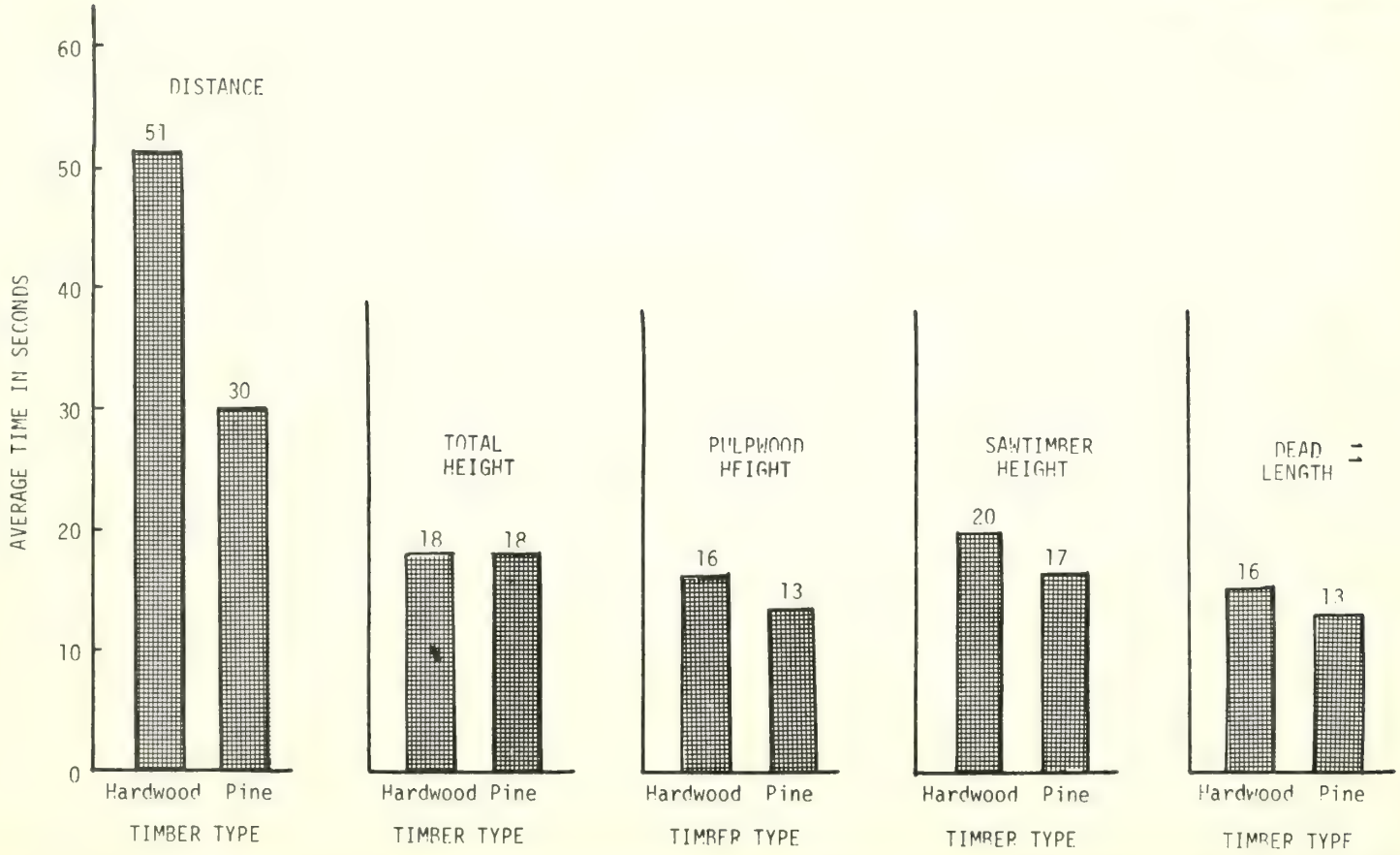


Figure 5. Average time to measure out from the tree and make tree height measurements on hardwood types on CFI plots on the Nash School Forest.

Stand Conditions

All of the plots were not located in the ne stand and site conditions; therefore, i seemed desirable to see whether stand nditions affected performance. Appar- ly it made no difference in perfor- nce between establishing plots in the ttomlands and the uplands, since all of t crews performed just as well in one as the other. However, the density of the stand in which the plots were established did make a difference. Crew C did much better in high density bottomland stands, those which had 70 percent and over crown closure, than in low density bottomlands. And in the uplands, all crews showed significantly better performance in high density stands than they did in low. Table 7 shows this comparison.

Table 7. Trees measured per man-hour within the CFI plot in uplands on the MSU School Forest.

Crew	High Density 70% and over crown closure		Low Density Under 70% crown closure	
	No. Obs.	Trees per Man-hour	No. Obs.	Trees per Man-hour
A	7	7.7	9	4.1
B	87	7.3	22	5.6
C	25	6.3	15	3.8
Average All Crews		7.1		4.5

When looking at the average of all ews, we find that performance in the and types was 51 percent better in h density stands than in low density nds. This can probably be explained by to factors. In low density stands more he would be lost in going from tree to te and with a sparse overstory more bri- and low brush would be present.

As previously stated covering all plots ablished, crew B performed much bet- than crew C while within the plot. ter further analysis it was found that w B's performance was not signifi- ntly better than C's in high density nds, but was 30 percent better in low density stands. Therefore, it is concluded that since crew C had 3 men performing all within plot measurements while crew B had only 2 for many of them, dense stands could keep 3 men busy and thin stands could not.

Another point must be considered, however. Almost half of the within plot time was spent in measuring the tree heights. Table 8 shows crew B was 46 percent faster in measuring tree heights than crew C in low density stands, even though the tree heights were measured during the time when each crew had 3 men participating. Thus it appears that part of the difference in performance is a difference

3/ Where clover disappears in the grass-clover mixtures apply 50 lbs. N in the fall.

Table 8. Trees measured per man-hour for height measurements by crews and plot density on CFI plots on the MSU School Forest.

Crew	High Density 70% and over crown closure		Low Density Under 70% crown closu	
	No. Obs.	Trees per Man-hour	No. Obs.	Trees per Man-hour
A	19	7.0	9	4.1
B	103	7.3	22	5.6
C	41	6.7	18	3.8
Average All Crews		7.1		4.7

in crew capability. Crew B was not significantly faster in measuring tree heights in low density stands than crew A.

In addition to different densities, the plots fell in different timber size classes. Three classes have been recognized for this analysis. Seedling-sapling stands, where at least 2/3 of the trees were below 3.5 inches d.b.h.; poletimber stands, where at least 2/3 of the trees fell between 4" and 12" d.b.h.; and sawtimber stands, where at least 2/3 of the trees were 12" d.b.h. and above. Table 9 shows performance by each of the crews within each of these stand classifications. There was no significant difference between performance of the crews in the seedling-sapling stands, but crew B performed 0 percent better in the poletimber stands than crew C and 54 percent better in sawtimber stands than crew A. The above holds when we consider all within plot activities.

Table 9. Trees measured per man-hour within the CFI plots by crews and size classes on the MSU School Forest.

Crew	Size Class of Plot					
	Seedling-sapling		Poletimber 4"-12" dbh		Sawtimber 12" dbh and p	
	No. Obs.	No. Trees	No. Obs.	No. Trees	No. Obs.	No. Trees
A	5	4.6	17	7.2	6	4.0
B	16	4.6	61	8.3	48	6.2
C	7	3.0	24	6.9	28	5.6
Average All Crews		4.1		7.5		5.3

It is also of interest to see how all crews combined performed within different size classes. For all within the plot activities as judged by trees measured per man-hour, all crews performed much better in poletimber stands than in either the seedling-sapling or the sawtimber stands. Crew A performed 80 percent better in poletimber stands than in sawtimber and 57 percent better than in seedling-sapling stands. Crew B was 80 percent faster in poletimber stands than in seedling-sapling ones and 34 percent faster than in the sawtimber stands. Crew C was more than twice as fast in poletimber stands than in seedling-sapling stands and 2 percent faster than in sawtimber stands. Crew C was also 85 percent faster in sawtimber stands than in seedling-sapling stands.

Table 10 shows performance of each of the crews within these stand size classifications in measuring the tree heights. Again there was no significant difference in performance between the crews in the seedling-sapling stands. However, in the poletimber stands crew B was 26 percent faster than crew C and 21 percent faster than crew A. In sawtimber stands crew B performed 36 percent better than crew A.

All three crews measured tree heights faster in poletimber stands than in sawtimber stands. However, only crew B measured faster in poletimber than in seedling-sapling stands.

Crew A was 49 percent faster in poletimber than in sawtimber stands, while crews B and C were 32 percent and 33 percent faster respectively. Crew B was also 30 percent faster in poletimber stands than in seedling-sapling stands.

Crew A

A sub-sample of 20 plots which were established by crew A were used for a very detailed time study. This crew made only one trip to the plot and completed all measurements before leaving, except in a few cases when they were unable to finish on a given day and had to return the following day to complete the job.

It was believed that with accurate measurements of stand conditions and other

Table 10. Trees measured per man-hour for height measurements by crews and size classes on CFI plots on the MSU School Forest.

Crew	Size Class of Plot					
	Seedling-sapling		Poletimber 4"-12" dbh		Sawtimber 12" dbh and up	
	No. Obs.	No. Trees	No. Obs.	No. Trees	No. Obs.	No. Trees
A	5	10.6	17	15.8	6	10.6
B	16	14.7	61	19.0	48	14.5
C	7	12.6	24	15.1	28	11.4
Average All Crews		14.5		17.6		13.1

3/ Where clover disappears in the grass-clover mixtures apply 50 lbs. N in the fall.

variables it should be possible to predict man-hour requirements for future plot establishment under similar conditions. Therefore a multiple regression was computed with man-hours within the plot as the dependent variable and independent variables of (1) number of measured trees, (2) plots previously established, (3) density (percent crown coverage), (4) number of understory stems, and (5) time of day at mid-point of plot establishment. Only two of these variables, number of measured trees and number of plots previously established, were significantly associated with the man-hour requirements within the plot.

An equation was fitted which included only these two independent variables and is:

$$\hat{Y} = 4.00 + 0.089\ X_1 - 0.096\ X_2$$
$$n = 20 \quad R^2 = 0.90$$

where Y = man-hours spent within the plot

X_1 = number of trees measured on the plot

X_2 = number of plots previously established by the crew

n = number of observations

R^2 = coefficient of multiple determination

Figure 6 shows regression lines for the two independent variables which were computed from the equation. As the number of measured trees increased on the plot a steep increase in man-hours was required, and with an increase in crew experience as measured by number of plots established, we find a strong decrease in man-hour requirements. A word of caution is in order here about extending this formula beyond the data. Obviously the crew could not increase in efficiency indefinitely. In fact, it appeared to be in leveling off at around 30 plots. Therefore it is suggested that the formula not be used beyond 30 plots.

Table 11 shows the mean values of the dependent and the independent variables, along with their ranges.

The consideration of these indepen-

Table 11. Mean values and ranges of variables measured in CFI plot establishment on the MSU School Forest with a two man crew (crew A).

Variable	Mean Value	Range of Values
(Dependent) Man-hours within the plot	4.98	1.6-10.8
Independent		
Number of trees measured on the plot**	35.8	6-78
Number of plots previously measured*	22	9-34
Percent crown coverage	52	5-100
Number of understory stems on the plot	624	10-2010
Time of day	1230	0820-1642

**Significantly associated at 1% level

*Significantly associated at 5% level

dit variables was based on observation e the crew's performance in the initial ases of the study. Plots which had den- s underbrush did tend to impede the ac- tities of the crew, but turned out to be ignificant in this case.

Since almost one-half of the within plot time was consumed while measuring tree heights, a similar regression was computed using as the dependent variable man-hours expended while measuring tree heights and the same set of independent

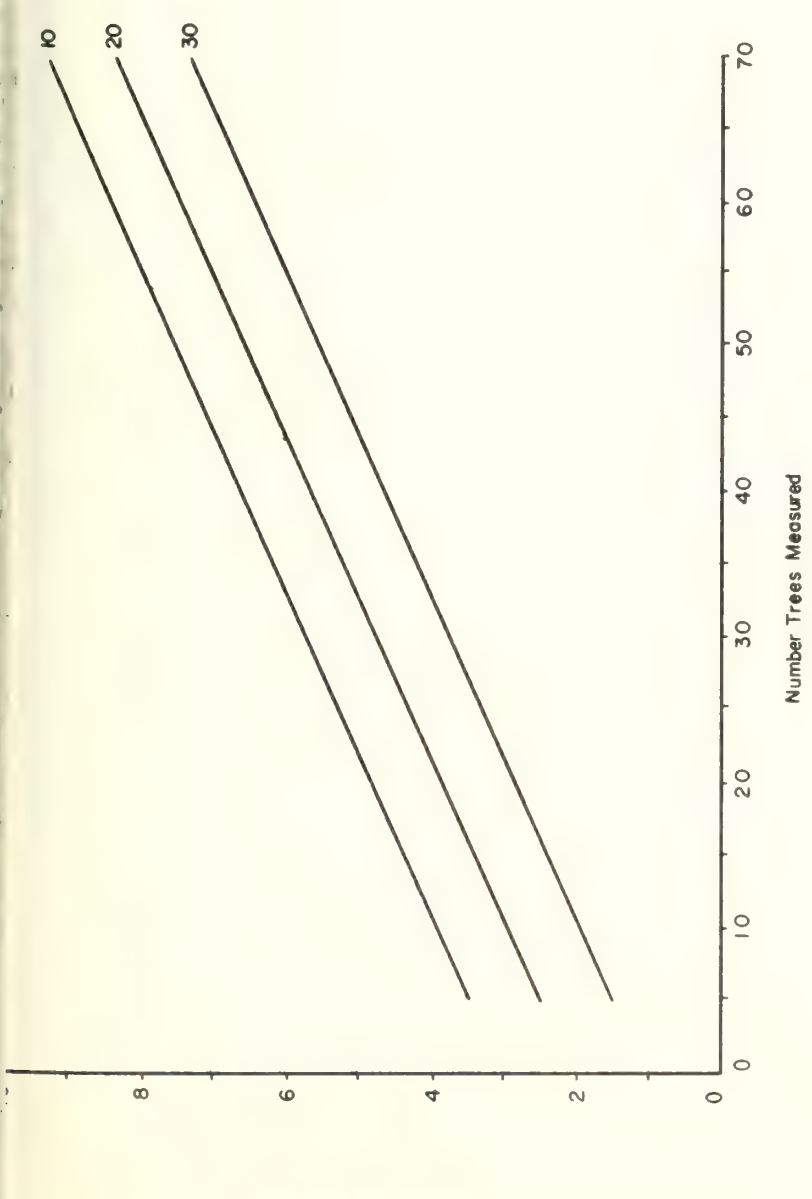


Figure 6. Relation of man-hours within plot to number of trees measured and crew experience.
Equation: $\hat{Y} = 3.999 + 0.0890X_1 - 0.0960X_2$ $R^2 = 0.90$ $n = 20$

3/ Where clover disappears in the grass-clover mixtures apply 50 lbs. N in the fall.

variables. The mean value of this dependent variable was 2.25 and the range was from 0.33 to 6.30 man-hours. Again the only independent variables which showed significance were the number of trees measured on the plot and the number of plots previously established.

A regression was computed using only these two independent variables and the following equation was fitted.

$$\hat{Y} = 1.109 + 0.0629X_1 - 0.0452X_2$$
$$n = 28 \qquad R^2 = 0.75$$

where Y = man-hours per plot measuring tree heights

X_1 = number of trees measured on the plot

X_2 = number of plots previously established by the crew

n = number of observations

R^2 = coefficient of multiple determination

The regression was highly significant and accounts for 75 percent of the variation in man-hours required in making height measurements. And again we find that as the number of trees measured increases it takes more time, and efficiency increases significantly as the crew gains experience. The experience factor should not be assumed to maintain this effect beyond 30 plots.

Seasonal Comparisons

One would suspect that general weather conditions might influence work performance. And in this case crew A was significantly faster in completing within the plot activities in January than either October, November, or December. The crew was also significantly faster in November than in October, but not significantly faster in November than December. Neither was the difference between December and October significant.

Performance was best during the month of January while they were working in dense stands. Although the weather was cool and sunny during the October working period, it is believed that lack of experience for the crew caused poorer performance than otherwise would have been the case. The weather during January was cold and cloudy and generally disagreeable; however, it was observed that the men worked faster in order to counteract the cold. Also in January the crew had gained over 25 plots of experience.

Crew B

Data was collected on 125 sample plots that were established by Crew B. This crew consisted of two men who located the plot, witnessed the plot center, tagged the trees 3.5" d.b.h. and up, and numbered these trees. They then proceeded on to the next plot, performing the same activities. Later a third man would accompany them back to these plots and complete the measurements on the trees.

A series of regressions were computed on data collected from these plots. The first one had as the dependent variable man-hours required to perform within plot activities and independent variables of (1) number of trees measured on the plot, (2) percent crown coverage, (3) sum of diameters of the measured trees, (4) number of sawtimber trees measured, and (5) percentage of the measured trees that were of pulpwood size. Another was run using the same independent variables but using man-hours measuring tree height as the dependent variable.

Table 12 shows the mean values and the ranges of the variables. The only independent variables which showed a significant association with total man-hours required within the plot were the number of trees measured and the sum of diameters.

Since crew B visited each plot twice and measured parts of plots on each visit it was not possible to evaluate the experience factor.

lan-hours per plot within the plot d be estimated from an equation ch was fitted using only number of s measured on the plot and the sum of heir diameters. This equation shown w, accounts for 82 percent of the var- on in man-hour requirements within plot and was highly significant. Figure as prepared from this equation.

$$\hat{Y} = 1.02 + 0.0465X_1 + 0.00538X_2$$

$$n = 125 \qquad R^2 = 0.82$$

re Y = man-hours spent within the plot

X_1 = number of trees measured on the plot

X_2 = sum of diameters of the measured trees

n = number of observations s

R^2 = coefficient of multiple determination

e number of trees measured on the t has such an important influence on the time it takes to establish the plot that a simple regression using number of trees measured on the plot as the only independent variable gives a highly significant regression and accounts for 79 percent of the variation. An equation for this simple regression is shown below, and might be useful in approximating the man-hour requirements.

$$Y = 1.244 + 0.834X$$

$$n = 125 \quad r^2 = 0.79$$

where Y = man-hours required within the plot

X = number of trees measured on the plot

n = number of observations

r^2 = coefficient of determination

Since about one-half of the time spent on the plot was in making the tree height measurements, again a regression was computed using man-hours measuring tree heights as the dependent variable and

le 12. Mean values and ranges of variables measured in CFI plot establishment on the MSU School Forest with a two and three man mixed crew (crew B).

Variable	Mean Value	Range of Values
pendent:		
Man-hours within the plot	3.33	0.47-9.19
dependent:		
Number of trees measured on plot	24.9**	0-60
Percent crown coverage	75	5-100
Sum of diameters of measured trees (inches)	217*	0-556
Number of sawtimber trees	6.6	0-24
Percent of measured trees that were pulpwood size	65.6	0-100

**Significantly associated at the 1% level

*Significantly associated at the 5% level

3/ Where clover disappears in the grass-clover mixtures apply 50 lbs. N in the fall.

cance was the sum of diameters of the measured trees. Therefore, a simple regression was fitted with man-hours measuring tree heights as the dependent variable and sum of diameters of the measured trees as the independent variable. This regression accounted for 88 percent the same independent variables as before (see Table 12). The mean value of man-hours measuring tree-heights was 1.56 with a range from 0.0 to 5.80. In this case the only variable which showed significance of the variation and was highly significant. The simple regression is presented below:

$$\hat{Y} = 0.00729X$$

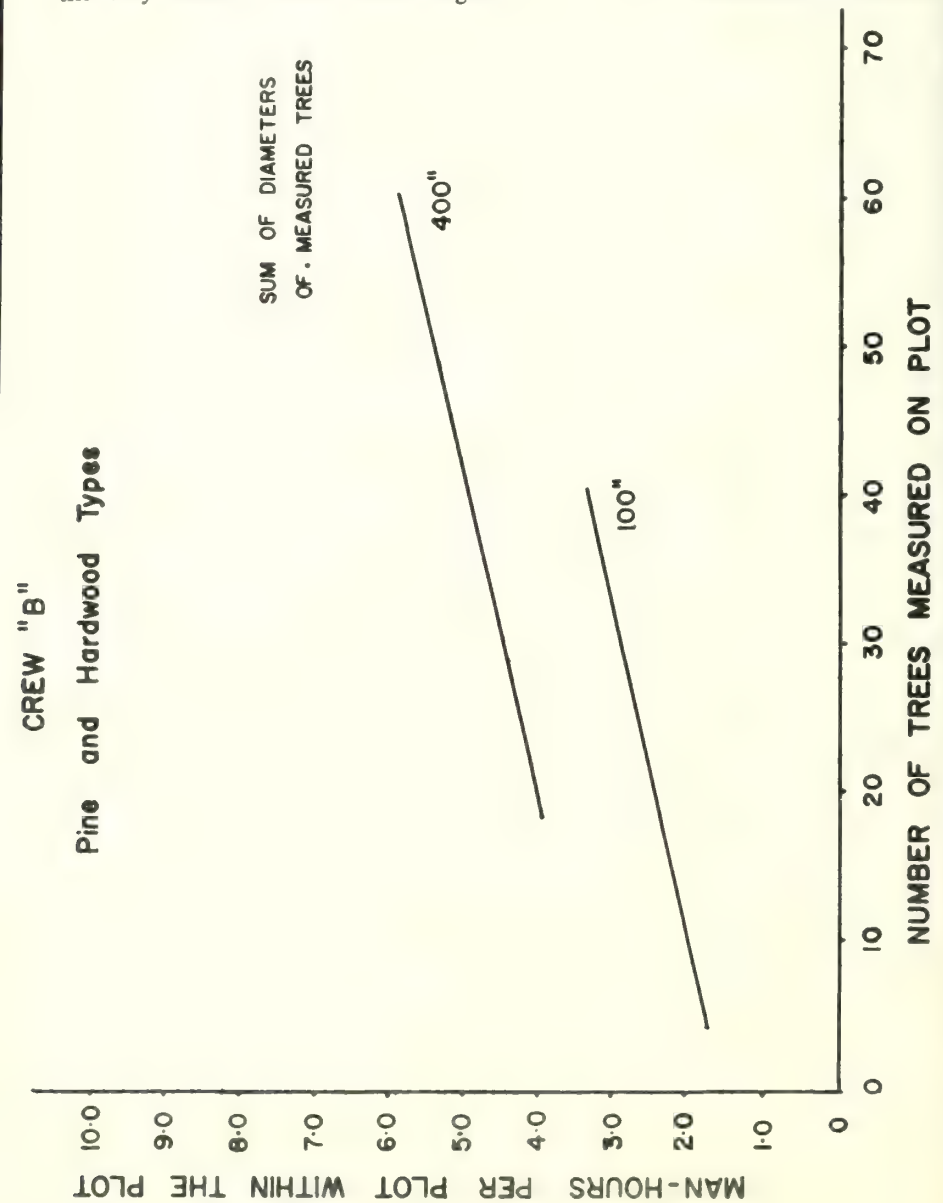
$$n = 125 \quad r^2 = 0.88$$

where Y = man-hours required in measuring tree heights

X = sum of diameters of measured trees

n = number of observations

r^2 = coefficient of determination



Crew C

During the establishment of the CFI ots a third crew was used and time data re collected for 59 plots. This was a ree man crew which made two trips to ch plot. On the first trip they located e plot, witnessed the plot center, mar- d, and tagged the trees that were 3.5" b.h. and above. They then proceeded to e next plot and performed the same sks. Several days later they returned d completed the measurements, de- riptions, and recorded data on the mark nse cards.

The analysis of data collected from ese plots was similar to that for crew B. series of regressions was computed with e first having as the dependent variable, an-hours required within the plot and e same five independent variables as ere used in the crew B analyses. A sec- nd regression was computed using man-hours while measuring tree heights as the dependent variable. Table 13 shows the mean values and the ranges of the values for the variables.

In the first regression only the sum of diameters and the number of sawtimber trees measured were significant. The regression was highly significant with a coefficient of determination (R^2) of 0.78.

A regression was fitted using these two variables and the equation is shown below.

$$\hat{Y} = 1.455 + 0.0163X_1 - 0.132X_2$$
$$n = 59 \quad R^2 = 0.77$$

where Y = man-hours required within the plot

X_1 = sum of diameters of the measured trees in inches

X_2 = number of sawtimber trees measured

n = number of observations

R^2 = coefficient of multiple determination

ble 13. Mean values and ranges of variables measured in CFI plot establishment on the MSU School Forest with a three man crew (crew C).

Variable	Mean Value	Range of Values
pendent:		
Man-hours within the plot	4.19	1.15-11.7
ndependent:		
Number of trees measured on plot	26.3	1-66
Percent crown coverage	68	5-85
Sum of diameters of measured trees (inches)	212*	6-420
Number of sawtimber trees	5.4*	0-18
Percent of measured trees that were pulpwood size	74.6	0-100

*Significantly associated at the 5% level

3/ Where clover disappears in the grass-clover mixtures apply 60 lbs. N in the fall.

Crew performance again was influenced by the number and size of trees which had to be measured on the plot. However, this crew was significantly influenced by a factor not influencing crew B. As the number of sawtimber sized trees increased on the plot, while holding the other factors constant crew C's performance increased. They were able to work faster with large trees than with small ones.

Another multiple regression was computed to find out which stand characteristics influenced the time in measuring tree heights. In this case only the sum of diameters of the measured trees had a significant influence. The regression accounted for 67 percent of the variation, and after further analysis it was found that a simple regression with sum of diameters of the measured trees as the independent variable was highly significant and accounted for 63 percent of the variation in man-hours while measuring tree heights. This regression equation is presented below.

$$\hat{Y} = 0.01\ X$$

$$n = 59 \quad r^2 = 0.63$$

where Y = man-hours required while measuring tree heights

X = sum of diameters of measured trees in inches

n = number of observations

r^2 = coefficient of determination

As a rule of thumb, one could get the approximate man-hours required to measure tree heights by pointing off two places in the sum of diameters of trees to be measured on the plot.

SUMMARY AND CONCLUSIONS

A detailed time study was made during the establishment of a CFI system on the MSU School Forest. A total of 324 circular plots 1/5 acre in size was established and a time study was made on 212 of the plots. These study plots were locate in 128 different 40 acre compartment 8 timber types, 4 density classes, 4 te classes, and covered a range of trees r a sured on an individual plot from 0 to 9

Three different crews took part in e plot establishment and time data w e collected from each crew's work. On 3 of the study plots the researcher trave d with the crew and recorded time o 7 distinct activities with a stop watch. n the other 159 plots, five activities w e timed and recorded by the tallyman.

The weighted average of man-hour quirements per plot was 7.42. This c ered all 212 samples established by a 3 crews. Within the plot time was 33 man-hours and off the plot activities c sumed 3.50 man-hours per plot.

On the basis of work performed wit the plot, crew B was over 19 perc t more efficient than crew C, but not nificantly more efficient than crew Thus the crew organization and techni e of crew B, which was two men locat the plot and marking the trees, then th men returning to make the tree meas ments, was superior to crew C, which h three men taking two trips. However, two man crew making only one trip m sured only one less tree per man-ho which was not significantly slower.

Driving to the forest, which avera 14 miles one way required 44 percent f the man-hours consumed off the plo After the crews were in the woods it to on the average 2.04 man-hours per plot mark a reference starting point and cha to the plot location.

While within the plot, the most ti consuming activity was measuring t tree heights which took 47 percent of t time for the two man crew. It took l than 1/4 of this time to make the d.b measurements.

All crews performed within plot acti ties just as well in bottomlands as in u lands; however, on the average they co

ted measurements and descriptions on
percent more trees per man-hour in
h density uplands than in low density
lands. Also performance was signifi-
ntly higher in poletimber stands than in
wtimber or unmerchantable stands, 42
rcent more trees measured per man-
ur in poletimber stands than sawtimber
nds.

Performance for the two man crew
hich made one trip to the plot was in-
enced primarily by number of trees
at had to be measured on the plot and
w experience. However, performance
s also higher in January than either
tober, November, or December.

The crew which had two men on the
st trip to the plot and three on the next
p had performance affected primarily
number of trees measured per plot and
e sum of the tree diameters. These were
o the most important factors influenc-
g performance of the three man crew
hich made two trips to the plot.

For someone planning to establish a
I system both the two man crew mak-
g only one trip to the plot and the crew
here two men make the first trip and
ree men follow later and finish the
ork should be considered. If the plots
e widely spaced and travel time is great,
en two men making only one trip
ould probably be preferable.

Under existing conditions the crew
here two men made the first trip to the
ot followed by three men on a second
ip had some advantages.

Having to carry only part of the equip-
ent in each of two trips rather than all
f it on one trip made the job much more
nvenient. Also by completing only about half of the activities on the first trip a more efficient routine was established, and separating the critical measurements of the trees from the other activities allowed the use of less experienced personnel on the first trip.

In this type of crew organization, two men locate the plot center, witness the plot center, tag and number the trees, then proceed on to the next plot. Later a three man crew would return to the plot; record and measure the individual trees along with recording the plot data including type, density, site, size class and reproduction count.

An estimate of man-hours required per plot while within the plot for the above crew organization is illustrated below.

From forest inventory information, estimate the average number of trees that would be measured on the plot and the sum of their diameters.

Average number of trees per plot to be measured	20 inches
Sum of diameters	200

Then from the formula on page 19 substitute this data:

Man-hours per plot = 1.02 + 0.0465 (20) + 0.00538 (200) = 3.02

Then if a total of 200 plots were needed, 604 man-hours would be required for within the plot activities (200 x 3.02).

Since travel time and off the plot activities time would vary greatly from one property to another depending on spacing of the plots and distance the crew had to travel, each firm would need to make an individual estimate of them.

3/ Where clover disappears in the grass-clover mixtures apply 60 lbs. N in the fall.

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1973 CROP AND FERTILIZER RECOMMENDATIONS FOR MISSISSIPPI

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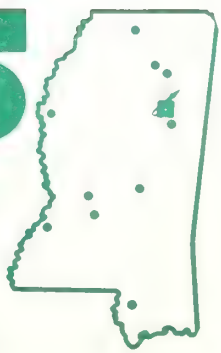
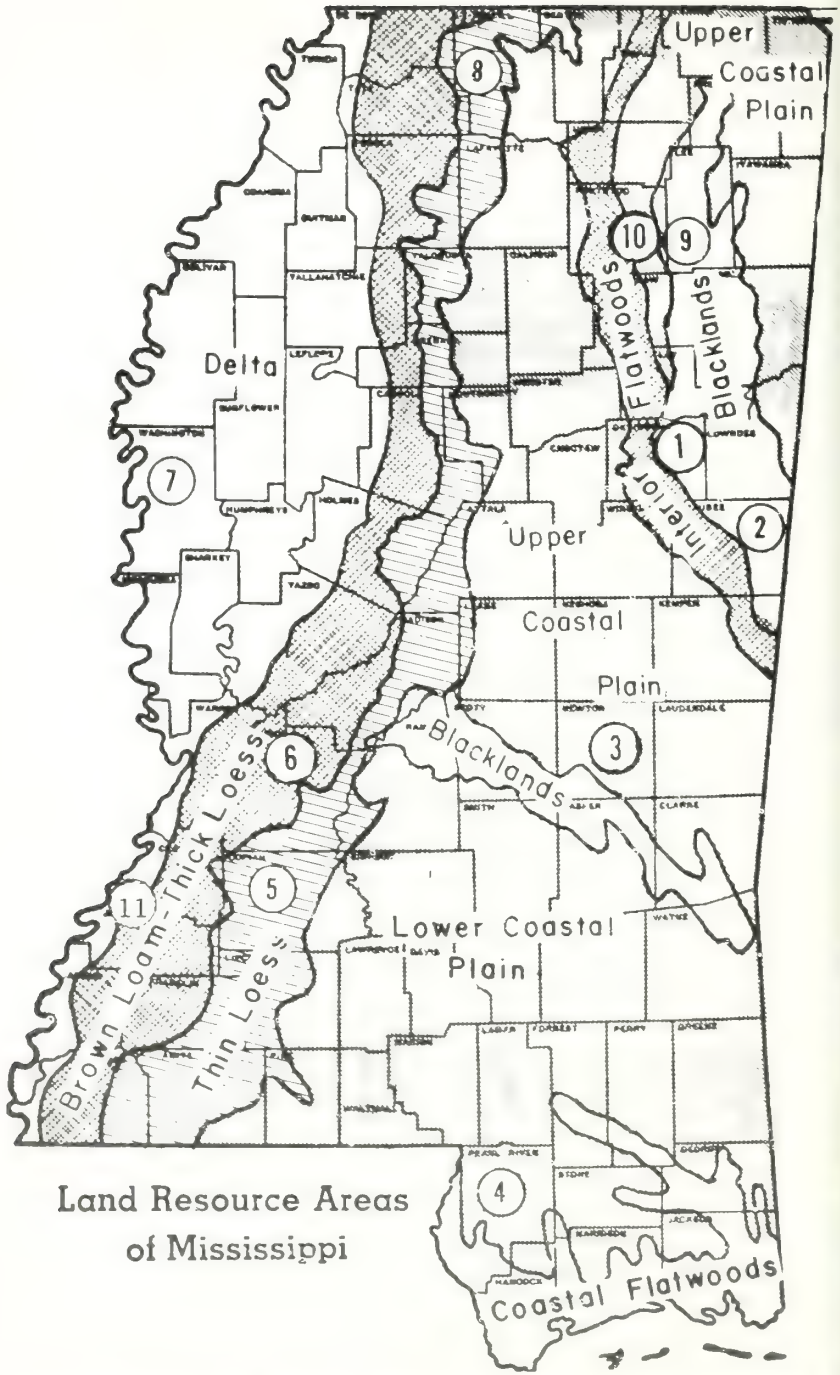


3/ Where clover disappears in the grass-clover mixtures apply 60 lbs. N in the fall.



Land Resource Areas of Mississippi

This map shows land resource areas of the state and how Experiment Sta
locations fit into them. Number 1 is the main station at State College. Branch stat
are: 2 Brooksville, 3 Newton, 4 Poplarville, 5 Crystal Springs, 6 Raymond, 7 Stonevil
Holly Springs, 9 Verona, 10 Pontotoc, and 11 Alcorn.

CROP AND FERTILIZER RECOMMENDATIONS FOR MISSISSIPPI

rop and fertilizer recommendations are
mle annually by the Mississippi Ag-
ri ltural and Forestry Experiment Station.
T se recommendations incorporate the
la st research findings at State College and
th Branch Experiment Stations. Included is
in rmation on varieties and fertilization
a seeding practices for crops commonly
g wn in the state, as well as information on
la ns and other turf areas.

ecause of varying soil and weather
c ditions and other local factors, no single
c p variety or fertilizer recommendation is
s able for all the state; nonetheless, these
g eral recommendations are useful guides
f crop production. Of course these
r ommendations assume that other good
f ming practices will be followed.

f more specific information is needed, it
n y be obtained from the Cooperative
E ension Service, the Experiment Station,
y r County Agent, or other trained
a icultural workers in your locality.

Soil Testing Service

Maximum profit is obtained from fertil-
i r only when the right kind and amount are
e d on each field.

Through the Soil Testing Department of
t e Cooperative Extension Service every
f mer can get this information as well as
i ormation on liming practices. Further-
r re, the Soil Testing service makes recom-
e ndations for exceptionally high produc-
t n goals which may not be provided for in
e general recommendations.

Soil testing is a free service. Soil sample
b xes, mailing cartons, and instructions for
c llecting samples are available in each
c unty's office and the offices of other
a ricultural agencies.

Plant Nutrients

Plant nutrients may be divided into two
g oups: (1) Those elements used by crops in
r latively large amounts, the macronutri-
e ts; and (2) those needed in very small
a ounts, the micronutrients.

The first group includes nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur. These are usually subdivided into the primary fertilizer nutrients — nitrogen hosphorus, and potassium — and the secondary fertilizer nutrients — calcium, magnesium, and sulfur. The primary nutrients are applied to crops either as materials or as mixed fertilizers. A fertilizer material usually contains only one fertilizer nutrient. Some examples of fertilizer materials are listed below:

Material	*Total Nitrogen N*
Ammonium nitrate	34 percent
Anhydrous Ammonia	82 percent
Urea	45 percent
	Available Phosphate (P_2O_5)
Superphosphate	18 to 20 percent
	Available Potash (K_2O)
Muriate of potash	60 percent

Mixed fertilizers contain two or more of the fertilizer nutrients. Each fertilizer bag is labeled with a set of numbers to show how much of each nutrient it contains. The first number shows the percentage of nitrogen (N), the second one the percentage available phosphate ($P_2 0_5$), and the third the percentage water-soluble potash ($K_2 0$). One hundred pounds of a 5-10-10 fertilizer thus contains 5 lbs. of total N, 10 lbs. of available $P_2 0_5$, and 10 lbs. of available $K_2 0$. Fertilizer ratio refers to the relative amounts of these nutrients. The fertilizer grade gives the guaranteed amounts of each fertilizer nutrient as a percentage. For example 8-8-8 and 10-10-10 are two different grades in a 1-1-1 ratio. Similarly 6-8-8 and 9-12-12 are two grades in a 3-4-4 ratio. Materials such as ordinary superphosphate may be labeled as 0-20-0.

At present fertilizer nutrients are either expressed as the oxide, phosphorus as phosphorus pentoxide ($P_2 0_5$), or as the element, nitrogen as N, but there is a trend toward expressing all fertilizer nutrients on

3/ Where clover disappears in the grass-clover mixtures apply 60 lbs. N on the 1st

the elemental basis. Accordingly, phosphate would be expressed as (P) and potash as (K) by using the chemical symbols for phosphorus and potassium, respectively. The primary "fertilizer nutrients" expressed on the elemental basis would then be shown as N-P-K on the fertilizer bag. Some fertilizers are labeled both ways to familiarize consumers with the new labeling trend. When labeled on an elemental basis a 10-20-20 ($N\text{-}P_2O_5K_2O$) would become a 10-8.2-16.5 (N-P-K). The conversion factors for potash are: $K_2O \times 0.83 = K$; $K \times 1.21 = K_2O$. The conversion factors for phosphate are: $P_2O_5 \times 0.436 = P$; $P \times 2.29 = P_2O_5$. Only the method of labeling is changed not the plant nutrient value of the fertilizer.

For the most part fertilizer recommendations are given in this bulletin as pounds of N, P_2O_5, and K_2O needed per acre. Usually the farmer will have a choice of more than one fertilizer grade. For example, 48 lbs. N, P_2O_5 and 48 lbs. K_2O may be supplied with 600 lbs. of 8-8-8 or 400 lbs. of 12-12-12. Since some deviation from the general recommendation does not affect net profit greatly, it is not necessary to apply exactly the amount of N, P_2O_5, or K_2O as indicated.

Both the need for and the presence of the secondary nutrients in fertilizers is variable. Research has shown that sulfur deficiency is likely to occur on soils in the Hill Section when sulfur-free fertilizers are used. Accordingly, sulfur is recommended for crop production in this area especially for cotton and legumes. A convenient and economical way to get the sulfur is to use mixed fertilizers that contain sulfur. Most solid mixed fertilizers sold in Mississippi contain adequate sulfur, but most liquid mixed fertilizers do not unless special provision is made for its addition.

Scattered instances of sulfur deficiency have been observed in the Delta Area. These deficiencies have been associated with land leveling and very sandy soils that are low in organic matter. Since mixed fertilizers are less commonly used in this area, other sources of sulfur may be more economical or convenient to apply. Sources of sulfur that may be used include gypsum, elemental sulfur, ammonium sulfate, and ordinary superphosphate.

Calcium and magnesium are usually applied to soils as agricultural limestone, although a major objective of liming is to neutralize soil acidity. A more complete discussion of liming is given elsewhere. In soils needing magnesium but not requiring lime, the addition of a water-soluble source of magnesium to mixed fertilizers is a very convenient method of supplying the magnesium.

The second group of nutrients is referred to variously as "trace elements", "minor elements", and 'micronutrients.' They are needed by crops in very small amounts. Included are iron, manganese, zinc, copper, boron, molybdenum and chlorine. Thus far, only three (zinc, boron, and molybdenum) of these have been found to be deficient to an appreciable extent for crop production in Mississippi. These deficiencies have not occurred on all crops and have been restricted almost entirely to the Hill Section. Specific recommendations for micronutrients are given later for crops which need them.

Solid or Liquid Fertilizers

Mixed fertilizers are available in both solid and liquid forms. Liquid fertilizers have given, or would be expected to give excellent results in most cases, but they are no more effective than many, if not most, solid mixed fertilizers.

The inferiority of some solid mix fertilizers to liquid mixed fertilizers and other solids can be attributed primarily to the phosphate component of these fertilizers. Only highly water soluble phosphates are, of necessity, used in the formulation of liquid mixed fertilizers, but the water solubility as well as other characteristics of the phosphate materials in solid mixed fertilizer may vary widely. All highly water soluble phosphates are very effective fertilizers but all those of low water solubility are not.

Solid mixed fertilizers formulated with ammonium phosphates and normal ammoniated superphosphate contain a very

gh percentage of their phosphorus in a ater-soluble form and are just as effective liquid mixed fertilizers. Ammoniation of dinary and concentrated perphosphates to add nitrogen during the rmulation of mixed fertilizers, which is a mmon practice, converts some of the ghly effective water-soluble mono-calcium iosphate to water-insoluble calcium iosphate some of which may be somewhat s effective for crop production. This is rticularly true with ordinary superphos- iate (20 percent) because of the formation an apatite-like calcium phosphate, the iantity of which increases progressively th increasing ammoniation. In a sense new ck phosphate is formed. Consequently, ixed fertilizers formulated from highly nmoniated ordinary superphosphate are t as effective as liquid mixed fertilizers, or e high quality solids. Unfortunately, most the phosphorus in the apatite-like phos- iates formed upon ammoniation of ordi- ry superphosphate is determined to be vailable" by the chemical method rrently used for control purposes.

With the sources of phosphorus com- only used in the formulation of mixed rtilizers in Mississippi farmers are asonably assured of good results if 50 to 60 rcent of the "available" phosphorus is also ater-soluble. Some manufacturers give the ater-soluble phosphorus content of their rtilizers though this is not required by law.

A substantial amount of nitrogen in liquid ixed fertilizers is derived from urea and-or nmonium nitrate. As will be indicated later trogen solutions containing either urea or ea and ammonium nitrate have been much ss effective for surface application to mmer pastures than either solid urea or nmonium nitrate. Therefore, liquid mplete fertilizers would not be expected to e as effective for summer pastures as solid mplete (NPK) fertilizers.

Soil pH and Liming

Excessive soil acidity and associated ctors reduce crop yields. A recent mmary of soil test results by the Coopera- ve Extension Soil Testing Department showed that some 70 percent of the soils tested needed lime for legumes and 40 percent for no-legumes.

The degree of acidity or alkalinity of a soil is expressed by its pH; values below 7.0 indicate an acid soil, above 7.0 an alkaline soil. Soil reaction, or pH, affects the availability of some of the more important plant nutrients in the soil. Phosphate is much less available in very acid soils than in slightly acid to mildly alkaline soils. In strongly and very strongly acid soils (pH below 5.5) certain elements such as manganese and aluminum may become so available that they are toxic to plants. On the other hand micronutrients such as iron, manganese, boron and zinc rapidly become less available as the pH of the soil is increased above 6.0. This is one reason why soils should not be overlimed. Experience has shown that overliming injury in Mississippi is very likely to be associated with deficiencies of boron and zinc. In the case of cotton and legumes, it is very likely to be due to boron deficiency and with corn, and perhaps other grasses, to zinc deficiency.

Soils with a pH of 6.0 to 7.0 are well supplied with lime. If the pH is less than 5.5, the soil is strongly acid and needs liming. Most non-legumes grow best at soil pH values above 5.5 while most legumes do best if the pH is maintained above 6.0. Alfalfa does best at soil pH values above 6.5.

The amount of lime required to raise the pH of the soil to a desired value depends both on the initial pH and the lime holding capacity of the soil. For soils of Mississippi having a pH of 5.5 or slightly below, the application of 3000 pounds of lime per acre to sandy loam soils, 5000 or 6000 pounds to loam and silt loam soils, and 7000 to 9000 pounds to clay loam and clay soils, respectively, has satisfactorily corrected lime deficiency for legumes. Since about two-thirds of the soils of the state have pH values of 5.5 or above, and 95 percent above 5.0, these rates of lime would bring the pH of most of the soils of the state within the range that is favorable for legumes. However, some soils need more, some less, and some none. Therefore, the best practice is to test

3/ Where clover disappears in the grass-clover mixtures apply 50 lbs. N in the fall.

the soils for pH and lime requirement and apply lime as needed to maintain the pH within the desired range.

Lime is lost naturally from the soil by crop removal and by leaching. The use of acid forming sources of nitrogen and the turning under of legumes as soil builders accelerates leaching losses. For example, 100 pounds of nitrogen from such sources as ammonium nitrate, anhydrous ammonia and urea will cause the loss of calcium and other bases equal to about 200 pounds of lime. When applied annually at this rate, the loss would amount to one ton of lime every ten years due to fertilizer alone. Because of these losses, soils need to be limed periodically.

Generally, on sandy loam, loam and silt loam soils a maintenance application of 2000 to 3000 pounds of lime per acre once every 5 to 7 years is required for legumes and for non-legumes fertilized with nitrogen as recommended. On clay loam and clay soils less frequent but larger applications are required. Although lime may be needed badly on some soils for non-legumes, the deficiency is not widespread enough to warrant a general recommendation for rates in excess of maintenance requirements for these crops in the absence of a soil test. Areas going into permanent grass sod should receive the initial maintenance application of lime prior to establishment. Subsequent maintenance applications may be applied to the surface.

Except for the dark upland soils and the bottom soils of the Northeast Blackland area, maintenance application should be made to soils that have not been limed during the past 5 to 7 years.

The principal liming materials available in Mississippi are ground calcic and dolomitic limestones, crushed chalk or marl from Mississippi deposits and basic slag. Calcic limestones contain calcium carbonate while dolomitic limestones contain both calcium and magnesium carbonates. Liming materials from Mississippi deposits contain calcium carbonate only. Basic slag, a material containing a minimum of 6 percent P 0 and the equivalent of about 60 percent lime should be used only where both the lime and phosphate are needed. The cost of its use as a liming material only is prohibitive.

Research has shown that all of these materials are very effective in neutralizing soil acidity providing the calcic and dolomitic limestones are finely ground. Particles not passing a 40-mesh (40-holes per linear inch) are not very effective in neutralizing soil acidity. For this reason 90 to 100 percent of calcic and dolomitic limestones should pass a 10-mesh screen and 50 percent a 100-mesh screen. Particle size is not as important in the case of chalk because it contains clay impurity which causes the particles to break down within the soil. It must be crushed fine enough, however, to be spread uniformly.

Generally, the Delta and Deep Loess hill areas are abundantly supplied with magnesium, therefore, dolomitic lime is of no advantage in these areas. In the other soil areas of the state, however, magnesium levels tend to be lower and a liming material containing considerable magnesium, such as dolomitic lime, should be used; particularly in the Northeast Blacklands.

For best results lime should be mixed thoroughly with the top six to eight inches of the soil. However, depending on the texture of the soil, a maintenance application of 1000 to 2000 pounds per acre may be made as a surface application to permanent pasture or other permanent sods.

When to Fertilize

Following their application to the soil fertilizers become less available to plants. This occurs because they may be lost by leaching and volatilization or be converted to less available forms within the soil. Nitrogen is both leached and volatilized. Potassium is leached from some soils but phosphate is not. But phosphate is changed to less available forms.

Fertilizers may contain nitrate or ammonium nitrogen, or both, or other forms (urea and Cyanamide) that are changed rather rapidly to ammonium when applied to the soil. Nitrate salts found in fertilizers and in soils are highly soluble in water and are not retained chemically by the soil

erefore, they remain in solution and move ely with the soil water being easily leached m the root zone, particularly on sandy ms, loam and silt loam soils, or other soils ere water percolates readily. Under water-ged conditions, which are more likely in y soils, nitrates may be changed by soil cteria to gaseous nitrogen (denitrified) ich escapes into the atmosphere. nmonium nitrogen is not denitrified nor is easily leached, but it does not persist for g periods. It is changed (nitrified) by soil cteria to nitrate.

Since nitrogenous fertilizers are not held soils for long periods they are used more iciently for crop production when ap-ed at or near planting time or during the owing season.

Phosphate fertilizers are not lost by leach-g because they react with certain soil nstituents to become only sparingly uble in water. In acid soils the reaction is stly with iron and aluminum but in utral and alkaline soils calcium phos-ates of very low water solubility also are rmed. The soil-phosphate reaction oducts themselves become less available th time but the process is more rapid in id soils, particularly at pH values below).

The formation in soils of sparingly soluble osphates and their subsequent reduction availability to plants collectively is erred to as "phosphate fixation." Because fixation, greater efficiency generally is ob-ned from annual, seasonal applications osphate fertilizer than from less frequent off-season applications, especially on derately to strongly acid soils. Accord-gly, it is usually suggested that phosphate tilizers be applied at or just prior to anting, or near the beginning of the owing period for perennial crops.

Unlike phosphate, the effectiveness of tash fertilizers is not reduced greatly by kation in Mississippi soils. But there is me loss by leaching, particularly from the ore sandy soils. Where leaching is gnificant annual, seasonal applications sult in more efficient utilization of potash an less frequent or off-season applications. Because of uptake in excess of need and its removal in the harvested crop, annual and sometimes split applications of potash are necessary for optimum efficiency for forage crops.

Because of rising costs and labor shortages, farmers increasingly are more interested in greater mechanization, custom services, and in spreading their work load to increase efficiency. One way of spreading the work load is to increase land preparation and application of fertilizers in the fall where feasible for spring-seeded crops.

Fall application of nitrogen for spring-seeded crops is not practical in Mississippi but there are opportunities for fall application of phosphate and potash where fall plowing is practiced. Because of previous fertilization or native fertility, levels of available phosphate and potash in much of our good crop land now are at the point where only small increases in yield, if any, are obtained each year from the application of these fertilizers. At these fertility levels, which a soil test will show, no more than maintenance rates are needed for maximum economic returns from fertilizer. Under such conditions the crop yield is affected only slightly, if at all, by the time or method of application of the fertilizer. Here there is an opportunity for fall application of phosphate and potash in connection with fall plowing.

Fall application of phosphate and potash need not be restricted to conditions where maintenance rates are required. On slightly acid to Alkaline clay and clay loam soils of the Blackland Area that are very deficient in phosphorus, fall application of phosphate has been just as effective as spring application. Similar results would be expected on other soils having similar native pH values. Top yields also can result from fall application of phosphate or other soils that are low in available phosphorus; but, because of fixation, a higher rate would be needed in the fall than in the spring, especially on acid soils having a pH below 6.0. Eventually, though, the phosphate would build up in these very deficient soils to the point that a maintenance rate would be sufficient either for fall or spring application.

3/ Where clover disappears in the grass-clover mixtures apply 60 lbs. N in the fall.

Except for leaching losses, potash applied in the fall for spring-seeded crops would be expected to be about as effective as that applied in the spring. Leaching losses are not particularly significant on clay and clay loam soils. But, as indicated before, leaching losses do occur on the lighter soils. Leaching losses are reduced by broadcasting the fertilizer and maintaining the soil pH above 6.0 by liming. With broadcast application on properly limed soils, substantial losses by leaching probably would not occur except on light sandy soils. Potash losses by leaching can be compensated by higher rates of application which might be an acceptable alternative to spring application in some cases.

How to Fertilize

To obtain maximum utilization of fertilizers the two components of availability, namely chemical and positional, must be optimized concurrently. Chemical availability refers to the capacity of the fertilizer and its soil-reaction products to supply nutrients to plants. Positional availability refers to the location of the fertilizer with respect to the plant roots. For example, fertilizer placed in the soil a foot or so from the row is positionally unavailable to seedling plants.

The chemical availability of nitrogen and potassium in fertilizers usually is not affected greatly by degree of contact with the soil. However, the effectiveness of highly reactive phosphates is protected by reducing their contact with the soil which slows the rate of phosphate fixation. This may be done either by band placement in the soil or by granulation of the fertilizer at the factory. Since most solid fertilizers sold in Mississippi are granulated or pelletized, method of application has a greater effect on positional than on chemical availability.

To assure effective positional availability fertilizers should be placed so as to be intercepted by plant roots at an appropriate time, or be moved to plant roots with soil water. As plants grow and extend their roots both horizonally and vertically the volume of soil from which nutrients may be absorbed is increased. Consequently, fertilizers that are positionally unavailable during early pl t growth may be available later.

Phosphate does not move appreciably n soils and the movement of potash s somewhat limited, especially on soils f medium to fine texture. Therefore, these l- tilizers must be placed so as to be interce- ed by plant roots. For drill-seeded and r crops they should be placed in the soil d enough to be in the moist soil where pla s feed as they grow. For such crops, surf application or shallow incorporation, as disking, would be expected to give infer results because of poor positional availal- ity.

Nitrogen as nitrate moves with the s water to plant roots. Its over-all efficiency not affected greatly by degree of concent- tion or its location within the root zo except that enough nitrogen should positionally available for good growth young plants.

Nitrogenous fertilizers applied to t surface of dry soils remain positionally u- available for the most part until dissolv and moved down into the root zone by p colating water. Before ammonium nitrog in fertilizers is moved down into the r zone, it must be changed (nitrified) by s bacteria to nitrate, a process requiring two four weeks for completion in moist s during warm seasons. Unfavorable po tional availability is avoided by apply nitrogenous fertilizers far enough in a vance of the necessary transformation a movement into the root zone by rainfall occur by the time the nitrogen is needed the crop.

Localized concentration of immobile fe tilizer nutrients, such as phosphorus a potassium, near the row or drill, as resul from band application, provides a ve favorable opportunity for early interceptio by plant roots as well as for extensive ro development within the fertilized zone late a condition which contributes to optimu fertilizer efficiency. An outstanding benef from phosphorus is its favorable influen on the early growth and development plants. This effect is enhanced by localize placement of fertilizer near the row.

Although maximum efficiency of phosphate and potash is usually obtained by band placement for row crop and drill-seeded crops, top yields can be obtained with broadcast application of these fertilizers. But on soils that are low to very low in phosphate and potash, higher rates are needed for broadcast than for band application to obtain the same increase in yield. This is especially true where the fertilizer is incorporated by shallow disking instead of being plowed under.

Because of accumulation from previous applications, or because of high native fertility, only a small percentage of the row-crop land previously cropped to cotton and fertilized as recommended over a long period would be expected to be so low in phosphate and potash as to require an appreciable increase in the recommended rate to obtain essentially the same yields when broadcast as when banded beside the row.

A hazard of localized placement of the fertilizers near the row is salt injury to seeds and seedlings resulting in poor stands and stunted growth. Since fertilizer salts, such as nitrates and chlorides, move mostly upward and downward with soil water rather than laterally by diffusion, salt injury can be avoided by placing the fertilizer to the side of rather than beneath the seed. The distance of separation required depends upon the kind of fertilizer and the rate of application. For recommended rates of phosphate and potash and up to about 40 pounds of nitrogen per acre, the minimum distance of separation should be 3 to 4 inches to the side of and 2 to 4 inches below the seed. With higher rates of nitrogen or potash both the horizontal and vertical distances between seed and fertilizer should be increased, or the fertilizer should be broadcast and plowed under.

Surface application of phosphate and potash to sod crops is more effective than for row crops. This is due in part to the development and persistence of plant roots near the surface. Because it is both convenient and effective this method of application is recommended for maintenance fertilizers on perennial, close-growing crops.

Solid sources of nitrogen are much more effective for surface application to summer pastures than are the urea-ammonium nitrate solutions such as N-Sol-32 and uran. These solutions have ranged in effectiveness from 66 to 74 percent of that of solid ammonium nitrate. Urea solid has been equal to ammonium nitrate when applied in June, but when applied a month earlier its relative value was about 85 percent of that of ammonium nitrate.

Foliar Feeding

Plants absorb and utilize nutrients applied in solution to their leaves and if a deficiency exists, yields and-or quality may be improved by foliar application. Because they are required in such small amounts, very dilute nutrient salt solutions of the micronutrient (trace elements) may be used quite satisfactorily as foliar sprays to correct deficiencies without injury (burning) to foliage. In some areas foliar feeding of trace elements has become a somewhat standard practice for crop production. Frequently, micronutrients are applied conveniently and inexpensively along with insecticides and fungicides. A typical example is the application of boron to cotton with the insecticide. However, so far, under Mississippi conditions there appears to be no need for both foliar and soil application of micronutrients where they are needed for crop production.

The primary (nitrogen, phosphorus, and potassium) and the secondary (sulfur, calcium, and magnesium) nutrients, are absorbed in relatively large quantities by crops. Thus, to supply a substantial part of the total requirement of these nutrients without burning the leaves of plants would require several applications of rather dilute solutions during the growing season. Therefore, foliar feeding of these nutrients is not as feasible as foliar feeding of the micronutrients. Increases in the yield of cotton have been obtained in Mississippi under certain conditions from foliar feeding of the primary nutrients, but it has not been shown so far to be a desirable or economical alternative to soil application of these nutrients. Therefore, foliar feeding is not now recommended routinely in lieu of or as supplement to soil application of primary plant nutrients.

3/ Where clover disappears in the grass-clover mixtures apply 60 lbs. N in the fall.

Recommendations for Major Field Crops

Corn

Hybrid: Detailed results of hybrid corn trials are published annually in MAFES Research Highlights. Ample seed of hybrids with N-cytoplasm (resistant to Southern Corn Leaf Blight) should be available for 1972 planting. Seed sold in 1972 will be labeled as to type of cytoplasm and only N-cytoplasm hybrids should be grown.

Seeding Dates and Rates and Land Selection: Plant in North Mississippi from April 1 to April 25, in North Central Mississippi from March 25 to April 20, in South Central Mississippi from March 15 to April 15, and in South Mississippi from February 25 to March 15.

Corn should be planted on deep to moderately deep soil with fair to good surface drainage. Steep, droughty, and eroded hillsides are not well suited to corn.

Stands should be adjusted to yield and generally should be within the range of 12,000 to 18,000 plants for average yields of 80 to 100 bushels per acre, increasing with the yield. A good rule of thumb is to provide approximately 150 plants for each bushel of corn. Thus, on land that will produce an average yield of 80 bushels, the stand should be 12,000 plants per acre, for 100 bushels 15,000 plants, and for 120 bushels 18,000 plants. On land well adapted to corn, yields usually will fall within the range of 80 to 120 bushels per acre under good cultural practices. However, average yield goals in excess of 100 bushels per acre generally should not be set unless supplemental irrigation is available.

Fertilization—Hill and Delta Foothill Areas: Soils of the Hill and Delta—Foothill Area generally require a complete fertilizer for corn. Soils should be limed to maintain the pH above 5.5. Occasionally, following the application of lime, zinc deficiency may be encountered, especially on soils of medium to coarse texture. When this occurs, a mixed fertilizer which contains enough zinc to give 2-3 pounds per acre should be used for two to three years. No other micronutrient deficiencies have be observed in corn.

Time: Apply all of the phosphate a potash before planting. Nitrogen may applied before planting or in split a plications: one-fourth to one-third befo planting and the remainder as a side dressi by the time the corn is knee high.

Rate: Apply 120 to 210 pounds of nitrog and 40 to 70 pounds each of phosphate (P_2O_5) and potash (K_2O) in approximately 3-1 ratio, but adjust the rate to the expect average yield. For an expected yield of 1 bushels per acre the rate is 210 lbs. N, 70 lb P_2O_5, 70 lbs. K_2O. At lower yields the rate reduced proportionately, being 162 lbs. 54 lbs. P_2O_5, 54 lbs. K_2O per acre for a 10 bushel yield and 120 lbs. N, 40 lbs. P_2O_5, 40 O for one of 80 bushels. If corn is grown f silage for more than one year, double the ra of K_2O.

Method: All of the phosphate and pota and up to 40 pounds of nitrogen per acre m be placed in a band located 3 to 4 inches one side and 3 to 4 inches below the seed. T remaining nitrogen may be drilled at least inches from the row, broadcast, or appli later as a side dressing. All or part of t nitrogen may be broadcast as a mixture wi phosphate and potash, however, t fertilizer should be plowed down as shou all broadcast applications of phosphate a potash. Preplant applications of anhydro ammonia should be placed at least 6 inch to the side of and 6 inches below the see

Place side-dress applications of nitrogen foot or more from the row, nonpressu solutions and solid sources at a depth of inches and anhydrous ammonia at a depth 6 inches. Surface, sidedress, application solid sources and nonpressure solutions almost as effective as in-soil placement.

Fertilization—Delta Area: For soils this area, only nitrogen is needed general for top production. Soil test for phospha and potash needs.

Time: Nitrogen may be applied just pri to planting or in split application: one-half

before planting and the rest as a side-essing before the corn is knee high.

Rate: 120 to 210 pounds of nitrogen per re, increasing the rate as the expected yield creases.

Method: Place preplant applications of trogen 6 or more inches from the drill row, n-pressure solutions and solid sources at a pth of 4 or more inches and anhydrous nmonia at a depth of 6 inches below the vel of the seed. Side dress applications of trogen should be placed 1 foot or more om the row, non-pressure solution and lid at a depth of 4 inches and anhydrous nmonia at a depth of 6 inches. Surface plication of solid sources and non-essure solutions is only slightly less fective than in-soil placement.

COTTON IN THE DELTA

Varieties: Results of variety tests are ublished annually in MAFES Research ighlights.

Seeding Dates and Rates: Plant as soon ter April 1, as weather permits, but not in old soil. Hill dropped—16 to 22 pounds of elinted seed per acre. Drilled—30 to 40 ounds of delinted seed per acre. Drilled for oss plowing—60 pounds of delinted seed er acre. Seed should be of good viability.

Fertilization: Delta soils generally need nly nitrogen for most profitable yields but eficiencies of phosphate and potash do ccur occasionally. This is especially true for otash on sandy loam and silt loam soils of ie Eastern Delta and Foothill Area. There-ore, soils should be tested for phosphate and otash needs. Also, sandy soils that are low organic matter or that have been leveled ould be tested for sulfur needs.

Time: Apply nitrogen in the spring at or rior to planting, except on sandy loam soils aving very good to excessive internal drain-ge and on clayey soils with poor surface rainage. On such soils, split application of itrogen should be made, one-half at or prior planting and the rest as a side dressing referably by mid-June. Split application of itrogen on clays with poor surface drain-ge is recommended because of possible loss of nitrogen by denitrification during wet periods.

Rate: On sandy loam, loam, and silt loam soils rates from 90 to 100 pounds of nitrogen per acre are recommended for solid planted cotton and for all skiprow patterns. One hundred to 120 pounds of nitrogen per acre is recommended for the silty clay loam, silty clay, and clays regardless of the planting pattern, except that for clays with poor surface drainage the rate should be 120 to 150 pounds of nitrogen per acre.

For cotton following soybeans or pasture sod, the nitrogen rate should be reduced 20 to 30 and 40 to 50 pounds per acre, respectively.

On soils where stalk growth is too rank, maturity too late, and boll rot is a problem because of excess nitrogen, the nitrogen rate should be reduced by 30 percent.

All nitrogen fertilizer recommendations are on the basis of a planted acre regardless of the planting pattern, that is, whether skip-row or solid.

Method: Same as for Delta Area corn.

COTTON IN HILL AREAS

Varieties: Results of variety tests are published annually in MAFES Research Highlights.

Seeding Dates and Rates: Plant between April 10 and May 10 as weather permits. Hill dropped—use 16 to 22 pounds of well delinted seed or 12 to 16 pounds of acid delinted seed per acre. Drilled—use 20 to 30 pounds of well delinted seed or 15-20 pounds of acid delinted seed per acre. All seed planted should be of good quality.

Fertilization: A complete fertilizer (NPK) containing sulfur and boron is needed in the Hill Sections. Fertilizers for the dark upland soils of the Northeast Blackland Area having a pH above 6.0 should contain enough water-soluble magnesium to supply at least one-half and preferably as much magnesia (MgO) as potash. On soils more acid than pH 6.0 magnesium deficiency may be corrected by applying dolomitic lime at the rate of one to two tons per acre, or as indicated by a soil test.

3/ Where clover disappears in the grass-clover mixtures apply 60 lbs. N in the fall.

Enough boron is provided when the mixed fertilizer contains boron and phosphate in the proportion of 0.3 pounds to 48, respectively, or boron to phosphate ratio of 1:160. No more than 0.5 pounds of water-soluble boron should be drilled with the fertilizer.

Acid soils should be limed according to soil tests to maintain the pH above 5.5.

Time: Apply the phosphate and potash and all or part of the nitrogen at or a few weeks before planting time. On deep sandy or sandy loam soils with very good to excessive internal drainage, side-dress one-half to two-thirds of the nitrogen for most effective results.Make side-dress applications of nitrogen by mid-June (a week or more earlier if anhydrous ammonia is used), or at early square formation.

Phosphate and potash may be applied in the fall under certain conditions—see section on When to Fertilize.

Rate: Apply 72 pounds of nitrogen (N) and 48 pounds each phosphate (P_2O_5) and potash (K_2O) per acre except as follows: Increase the nitrogen to 120 pounds and the phosphate and potash to 60 pounds each per acre on the dark upland soils of the Blackland Areas, and increase the nitrogen to 90 lbs. per acre on the well-drained bottom and on the level to gently sloping upland soils of the Upper Coastal Plain. Excessive stalk growth and delayed maturity indicate too much nitrogen. Somewhat stunted growth associated with yellowish green foliage and the early yellowing and premature shedding of the leaves indicate too little nitrogen. When these conditions are observed nitrogen rates should be adjusted accordingly.

Where a skip row planting pattern is followed the rate of nitrogen per planted acre should be the same as is recommended for solid cotton but the rate of phosphate and potash should be increased to 60 pounds of each per acre where a lower rate is recommended for solid cotton. In a 4 x 4 or 2 x 2 planting pattern there is, of course, only one-half acre of planted cotton.

Method: Same as for corn in Hill and Delta Foot Hill Areas. Contact placement of seed and fertilizer or placement direc beneath seed should be avoided.

If the phosphate and potash are appli broadcast, the rate should be increased to pounds of each per acre on soils known to somewhat low in these nutrients. A soil t will indicate such conditions. However, indicated before an increase in rate genera will not be required on land previou cropped to cotton and fertilized as reco mended. If a preemergence herbicide is to boradcast and worked into the soil, ph phate and potash applied broadcast shou be plowed down before the herbicide applied.

SOYBEANS

Varieties: For all areas north of U. Highway 84 use—Hill, Dare, Davis, L Lee 68, Mack, Pickett 71, Seemes and Bra (listed in order of maturity.)

South of U.S. Highway 84—Bra Hampton 266A, Hardee, and Pickett 71 cyst nematode-infested land.

Soils: Soybeans are adapted to all De soils and to most soils of the Hill area, b lower yields may be expected on drough soils such as eroded and shallow upla soils.

Seeding Dates and Rates: May 1 to Ju 15 except extreme South Mississippi May to June 20. Plant 40-50 pounds of good se per acre.

Inoculation: If not on land where a crop well nodulated soybeans has grown with the last five years, the seed should inoculated.

Fertilization—Delta Area: Soybea require no fertilizer on most Delta soils b many need liming. A soil test will indicate t need for lime as well as phosphate a potash.

In the Eastern Delta and Foothills Area molybdenum seed treatment is needed f top yields on all soils that were previous acid regardless of current lime status, a elsewhere in the Delta on soils having a p below 6.0. A seed treatment of ½ oz. sodium molybdate per acre, or its equivale is recommended.

Fertilization—Hill Area: In the Hill Are phosphate and potash as well as lime usual

re needed. Except for the dark soils of the Blackland Area of Northeast Mississippi, ome 70 percent of the soils of the soils of the Hill Area need lime for top yield. In the bsence of a soil test, apply a mixed fertilizer f 0-1-1 ratio that contains sulfur at a rate to ive 40 to 60 lbs. each of P_2O_5 and K_2O and 4 8 lbs. of sulfur per acre. The fertilizer may e banded or broadcast. If broadcast, it hould be plowed-in instead of disked-in for est results. If banded the fertilizer should be laced 3 to 4 inches below the seed. Avoid ontact placement with the seed as well as and placement directly beneath the seed. Much newly cleared land, as well as land in nfertilized pastures, is extremely deficient n phosphorus and the rates indicated above robably will not be adequate for most rofitable yields if this land is planted to oybeans. On such land the phosphate hould be increased to 80 pounds per acre for few years by using a mixed fertilizer of 0-4- ratio.

In some parts of the state double cropp- ng of small grain and soybeans may be racticed. In such a system it would be atisfactory to apply all of the phosphate and otash recommended for both crops to the mall grain but they should be broadcast and orked into the soil.

In the Hill areas a seed treatment of ½ oz. f sodium molybdate per acre, or its quivalent, is recommended for soybeans on ll soils and especially on soils having a pH elow 6.0

Because of injury to the bacterial culture, he inoculant and sodium molybdate or ther soluble molybdate salts, should not be remixed for more than 24 hours before eing applied to seed beans that are planted mmediately following treatment. Actually, he best practice is to apply the inoculant nd molybdate salt separately and then mix oth with the beans in the same operation.

RICE IN THE DELTA

Varieties: Long Grain: Bluebonnet 50, Starbonnet, Dawn and Bluebelle which nature in 150, 142,130, and 115 days espectively. Medium Grain: Nova 66 and Vista which mature in 125-130 days.

Seeding Dates and Rates: Rice can be seeded from mid-April to mid-June depending upon variety. The very early varieties should not be planted until June. Seeding rate 90 to 110 pounds if drilled and 110 to 135 pounds if broadcast or water seeded.

Fertilization: Apply from 100 to 140 pounds of nitrogen per acre on old crop land. New land will probably require no nitrogen for the first one or two years. The ammonium forms of nitrogen such as ammonium sulfate and urea are recommended. Fertilizer may be applied before seeding if covered by approximately 2 inches of soil. Otherwise, it may be applied just before the first flood or one-half before the first flood and one-half at the correct "joint stage." This stage occurs when the first internode or distance between the lowest two joints is ¾ inch for very early varieties, ½ inch for Starbonnet and 1½ inches for other varieties. If all the nitrogen is applied before the first flood, do not drain the field but maintain a continuous flood for the entire season.

SORGHUMS FOR GRAIN, SILAGE

Varieties for Grains: DeKalb BR 64, RS 700 and Acco 1093 are bird-resistant varieties with good yield potential which have the best resistance to anthracnose disease. Anthracnose infection is unpredictable and may vary in severity from year to year. The following bird-resistant hybrids will yield well if anthracnose does not develop: Funks BR 79, Penngrain BR,Funks BR 630 and McNair 546.

Bird-resistant varieties may be used for high energy silage, but these varieties may cause palatability problems especially when fed to milk cows in high production. Non-bird resistant varieties such as Funks G 522, DeKalb E 57 and Acco R 1090 may be damaged by birds, but are much more desirable for a high quality silage, or for grain in areas where birds are not a problem. The resistance to weathering found in bird-resistance is not as important when the grain is harvested for silage in a slightly immature stage.

Varieties for Silage:FSIA, FS24, NK300, Funks 102F.

3/ Where clover disappears in the grass-clover mixtures apply 60 lbs. N in the fall.

Varieties for Syrup: Dale and Brandis.

Seeding Dates and Rates: April 20 to July 15. Earlier dates are preferred. If first harvest is made by July 25, a second cutting can usually be made if soil moisture is adequate. Seed 5 to 7 lbs. of seed per acre in rows.

Fertilization: For comparable yields the soil fertility and fertilizer requirements of grain sorghum and corn are quite similar except that grain sorghum apparently requires less nitrogen.

For Grain: In the Delta Area only nitrogen is needed generally. Depending upon the average yield, apply 80 to 130 pounds of N per acre, the lower rate for average yields of 60 to 70 bushels per acre and the higher rate for average yields of 100 to 120 bushels per acre. For intermediate yields, intermediate rates of nitrogen are recommended.

In the Hill Areas phosphate and potash as well as nitrogen generally are required. For average yields 50 to 60 bushels per acre, apply 60 to 75 pounds of nitrogen (N) and 30 to 40 pounds each of phosphate (P_2O_5) and potash (K_2O) per acre. For average yields of 90 to 100 bushels per acre 100 to 130 pounds of N and 50 to 60 pounds each of P_2O_5 and K_2O.

Where a stubble crop is desired, apply an additional 40 to 60 pounds of nitrogen after the first crop.

Depending on soil productivity, average yields can be expected to range from 50 to 90 bushels per acre for early plantings where proper cultural and fertilization practices are followed. Average yields from late plantings (after July 1) would be considerably lower.

Sidedress applications of nitrogen should be made by the time six leaves are showing which normally occurs before the sorghum is ten inches high.

For Silage: Apply as for grain, except double the rate of potash.

Method of Application: Same as for corn.

SUGARCANE FOR SYRUP

Varieties: C.P. 36-111 and C.P. 67-500. On deep, well drained soils of light texture.

Seeding Dates and Rates: Cut seed cane at the top mature joint and at ground level, but do not strip before planting. Plant in the F (October 15) at the rate of 2 stalks, that place stalks end to end with a whole stalk the union. Plant the cane in 4-foot rows land that has been broken 5 to 6 inches de a few weeks earlier. To protect from cold a to provide good drainage, cover the cane 6 8 inches deep by forming a ridge over it that the drainage furrows between the ro are 2 to 4 inches deeper than the cane.

Fertilization: In the spring apply 40 to pounds each of nitrogen and phospha (P_2O_5) and potash (K_2O) per ac shortly after germination of the eyes or ju before re-growth from stubble. Place t fertilizer in a band so that it will be 4 to inches to the side of the row and 3 to 5 inch deep after the ridges have been worked dow or 1 to 2 inches deeper than the cane. Sid dress with about 30 pounds of nitrogen p acre before July. Place sidedressing nitrog in the edge of the root zone deep enough be in moist soil without being disturbed subsequent cultivation.

Top and cup the cane before freezir weather. Harvesting as much as a mon before processing improves syrup quali and reduces "sugaring."

GRASSES, LEGUMES, AND SMAL GRAINS

Supplementary Information on Pastu Recommendations for the Hill Section.

Planting: In most instances a grass-legu mixture will provide less expensive and mc nutritious pasture forage than grass alo Therefore where practical new pastu should be planted to the desired grass pl one or more legumes. The pasture should th be fertilized to meet the needs of the legun namely phosphorus, potash and lime needed. Rates of these nutrients sufficie for the legume will also be adequate for t grass. The legume should provide adequ nitrogen for both species through fixatic In general, it is unwise to apply fertiliz containing nitrogen to grass-legu mixtures.

Renovation of Grass-legume pastu Where the stand of legumes in a pasture h degenerated to less than 15 percent or h

been lost entirely, it would pay to reseed legumes. This is best done in the fall season. The pasture should be closely grazed or mowed and the clover seed broadcast or drilled along with a fertilizer containing phosphorus and potash as indicated by soil test (See page 19).

Planting: If equipment is available, drill or band placement of seed and fertilizer is recommended for the establishment of all pasture and forage crops. With small-seeded legumes and grasses, care must be taken not to seed too deep. A seeding depth no more than ½ inch is recommended. Most plantings are made by broadcasting the seeds on the soil surface. It is advisable to cultipack the seed bed immediately before or after seeding.

Fertilization General: For established pastures, solid and liquid complete fertilizers and solid sources of nitrogen may be top-dressed. On summer grass pastures, however, the efficiency top-dressed urea-ammonium nitrate (non-pressure) solutions has been quite low compared to solid ammonium nitrate.

Because of the wide variety of soils to which these pasture recommendations will be applied, and of the extensive nature of the typical commercial livestock operation in Mississippi, particularly beef cattle, the pasture fertilizer recommendations are generally presented as a range instead of a single and more arbitrary figure.

The lower limit of the recommendation is estimated to be sufficient for plant establishment and (1) for reasonable yields of forage on soils well adapted to the particular pasture crop under consideration, (2) for periods of economic stress during which it is still necessary to maintain a reasonable supply of cheap forage, and (3) where acreage per animal unit is not a serious limiting factor.

The upper limit of the fertilizer recommendations should be used where the (1) soil type, (2) management system, (3) type of livestock enterprise, and (4) economic trend are such as to justify the considerably higher yields of forage.

Fall application of phosphorus or potash to pastures is recommended if these nutrients are necessary to establish forage seedlings in the fall. However, spring application is slightly more effective for spring and summer growth of perennial plants and those which come up in the spring. In general, fertilizers should be applied as close as practical to the time they are to be used by plants, therefore seasonal, annual applications are indicated in the following tables on forage and pasture crops. If phosphate and potash are applied only once in two years, double the annual application rate.

Fertilization of Grass Pastures: The yield of grass forages is greatly increased by nitrogen fertilization and, where weather conditions do not limit growth, excellent response is obtained to high rates of therefore, the most economical rate will depend upon temperature, availability of moisture, and the use made of the additional forage.

Utilization of Forage: To insure maximum forage profit from fertilizer applied to pastures, livestock producers should add additional animals to fertilized pastures to use additional forage.

Caution: Excessive amounts of nitrogen applied in one application may result in grass tetany or nitrate poisoning.

To increase the utilization of the nitrogen or to obtain a more favorable distribution of pasture production, split applications of nitrogen are recommended for both summer and winter grass pastures, at 60-80 pounds each time.

Except for Coastal bermudagrass, where the last application may be as late as August 15, the last application of nitrogen to permanent summer pastures should be made no later than July 15, and two weeks earlier if anhydrous ammonia is used. Because of the frequency of drought, mid-summer applications of nitrogen are generally less effective than applications made in the spring and early summer. So more nitrogen should be applied in the spring than in summer.

It may be economical to apply up to 200 pounds of nitrogen per acre to millet and

3/ Where clover disappears in the grass-clover mixtures apply 60 lbs. N in the fall.

sudangrass; 180 pounds to common bermudagrass, dallisgrass, and bahiagrass, and 240 pounds to Coastal bermudagrass.

For summer temporary grazing crops, at least 50 percent of the total nitrogen should be incorporated into the seedbed with phosphorus and potash prior to planting. Use the remainder on the surface after each grazing or cutting.

Fertilization of Grass-legume Combinations: Forage legumes may be effectively used to supply nitrogen required by the associated grasses. When properly used, forage legumes, extend the grazing season, increase total forage production, increase forage quality and result in better utilization of land resources. The choice of legume species and cultural practices should be determined by when the forage is needed, availability of seed and price of seed. The application of nitrogen fertilizer to grass-legume swards will reduce the N-fixing efficiency of the legumes. Nitrogen should not be used on permanent grass-legume mixtures when legumes make up 15 percent or more of the stand.

Caution: Where conditions are especially favorable for legumes the danger of blo may prevent full utilization of legumes see ed alone or of grass-legume combinatio such as dallisgrass and white clov particularly in the Deep Loess area. T drilling of small grains or ryegrass into su a pasture in North Mississippi orchardgra will lessen the bloat problem and supp additional forage.

For winter growing grass-legume co binnations, the legume will supply t nitrogen needed by the grass. However sin grass-legume mixtures sometimes "grow of more slowly than grass alone fertilized wi nitrogen; it may be advisable to plant portion of the winter pasture to grass alo and use nitrogen fertilizer as recommend in the tables.

Inoculation of Clovers: All seed of clove and other forage legumes should inoculated with the proper culture prior planting. It is imperative that seeds of ne clovers like Arrowleaf be inoculated.

Selection of Varieties: The use of certifi seed will reduce the risk of bringing noxio weed seed onto the farm and result in bett performance.

Pasture or Hay Crop	Recommended Varieties	Rate of Seeding Per Acre	Time of Planting	Fertilization, lbs.-A / Annual Application
Alfalfa	Cody, Delta and Florida 66	15-20 lbs.	Sept.-Nov.	Test soil for lime, Phosphorus, and potash needs.
Bermudagrass	Coastal	20 bu. sprigs	Feb.-May[2]	150 to 240 lbs. N, 2-3 applications beginning June 1, for grazing, For hay, 300-400 lbs.N
Bermudagrass White Clover	Regal, Merit, or La. S-1	2 lbs.	Plant Clover Sept. -Nov.	Test soil for lime, phosphorus, and potash needs.
Fescue and White Clover	Kentucky-31Fescue, Regall or La. S-1 White Clover	Fescue Clover	Oct.-Nov. Feb.-May	Test soil for lime[3], phosphate, and potash needs[3].
Red Clover	Orbit or Kenland	10-15 lbs. seed alone or in small grains	Sept.-Nov.	Test soil for lime, phosphate and potash.
White Clover	Regal, La. S-1, or Merit	2-3 lbs.	Sept.-Nov.	Test soil for lime, phosphate and potash.
Arrowleaf Clover[4]	Meechee or Yuchi	12-15 lbs.	Sept.-Nov.	Test soil for lime, phosphate and potash.
Sorghum-Sudan hybrids	Commercial Varieties	20 lbs. in rows 35 lbs. broadcast	Apr.-June	60 lbs. N prior to planting. 60 lbs. N after 1st and 2nd cutting
Korean Lespedeza	Climax or Summit	20-25 lbs. seed in small grains	Feb.-Apr.	Test soil for lime, phosphate, and potash.
Oats	Coker 242, Nora, or Florida 501	120 lbs. for grazing 90 lbs. for grain	For grazing: early Sept. For grain mid-Oct.	Grazing: 60 lbs. N at planting and 60 lbs in Feb. Grain: 45 to 60 lbs. N March 1-March 15
Wheat	Arthur 71, Blueboy II Coker 68-15 or Holley	120 lbs. for grazing 90 lbs. for grain	Same as Oats	Grazing: Same as oats grain: 60 to 90 lbs. N about March 1.
Rye	Explorer or Elbon	120 lbs. for grazing	Same as Oats	Same as Oats.
Barley	Dayton, Harrison or Jefferson	Same as Wheat	Same as Oats	Same as Oats.

1/ **All areas should be soil tested for lime, phosphorus, and potash needs.**
2/ **If irrigated Coastal may be planted from April 1 to Sept. 1**
3/ **Where clover disappears in the grass-clover mixtures apply 60 lbs. N in the fall.**

RECOMMENDATIONS FOR PASTURES AND FORAGES IN HILL SECTIONS

Pasture or Hay Crop	Recommended Varieties	Time and Planting	Rate of seeding Per Acre	Fertilization, lbs./A Annual Fertilization[5/]
ESTABLISHED WARM SEASON GRASSES (PERMANENT)				
Bahiagrass	Pensacola, Wilmington, (Argentine—South Mississippi only)	Feb.-May	15 lbs.-A	120 to 180 lbs. N in split applications and 30 to 45 lbs. each of P_2O_5 and K_2O. Total application in a 4-1-1 ratio.
Bermudagrass	Common	Feb.-May	5 lbs. seed	Same as for Bahiagrass.
	Coastal	Feb.-May If irrigated plant as late as Sept. 1.	20 bu. of sprigs per acre	**For Grazing:** 120 to 240 lbs. N in split applications and 30 to 60 lbs. each of P_2O_5 and K_2O. Total application in 4-1-1 ratio. **For Hay:** 200 to 300 lbs. N in split application; 50 to 90 lbs. of P_2O_5; 100 to 180 lbs. K_2O. Total application in a 4-1-2 ratio.
Dallisgrass	Commercial	Feb.-May	10 lbs. (live seed)	Same as Bahiagrass.
Johnsongrass	Commercial	April 1 to -May 15	15-25 lbs. (live seed)	Same as for Coastal Bermudagrass.
ESTABLISHED COOL SEASON GRASSES (PERMANENT)				
Tall Fescue	Kentucky-31 or Goar	Sept.-Nov.	15 lbs.	80 to 140 lbs. N, split—fall and spring; 40 to 60 lbs. each of P_2O_5 and K_2O in a 1:1 ratio
Orchardgrass (North Miss. only)	Jackson or Boone	Sept.-Nov.	15 lbs.	Same as Tall Fescue

5/ Established Stands

Pasture Crop	Recommended varieties	Time of Planting	Seeding Per Acre	Fertilization, lbs./A. Annual Application
Warm Season Grass-Legume Mixtures (Permanent)				
Bahiagrass, Bermudagrass		As before	As before	**Establishment:** 60 to 100 lbs.
Dallisgrass with one of the following legumes.			As before	As before P_2O_5 a 1:1 ratio.
White Clover	Regal, La. S-1 Merit	Sept.-Nov.	1-3 lbs.	**Maintenance:** 40 to 60 lbs. a 1:1 ratio.
Crimson Clover	Dixie, Chief, Autauga or Tibbee	Sept.-Nov	25 lbs.	Same as above, For seed production add 0.5 to 1 lb. of boron.
Arrowleaf Clover[4]/	Meechee or Yuchi	Sept.-Nov.	10-15 lbs.	Same as Crimson Clover
Annual Lespedeza	Climax or Summit	Feb.-April	25 lbs	**Establishment:** 60 lbs. each of P_2O_5 and K_2O in a 1:1 ratio. **Maintenance:** 40 lbs. each of P O and K_2O.
Johnsongrass with one of the following for hay:	Commercial	Feb.-June	15-25 lbs. (live seed)	**Establishment:** 120 to 160 lbs. each of P_2O_5 and K_2O in a 1:1 ratio.
Alfalfa	Florida 66, Delta, or Cody	Sept.-Nov.	15 lbs.	**Maintenance:** 60 to 80 lbs. P_2O_5 and 180 to 240 lbs. K_2O in a 1:3 ratio plus boron.
Red Clover	Orbit, Kenland or Chesapeake	Sept.-Nov. or March-April on clean land.	10 lbs.	Same as with Alfalfa.
Rough Peas	Commercial, also known as Caley, Singletary, and Wild Winter Peas.	Sept.-Oct.	30 lbs.	60 to 90 lbs. P_2O_5 and 120 to 180 lbs. K_2O in a 1:2 ratio, 120 lbs. N after peas mature.

Recommendations For Pastures In Hill Sections—(Continued)

WARM SEASON GRASSES (ANNUAL OR TEMPORARY)				
Millet	All hybrid varieties	Apr.-June	15 lbs in rows 35 lbs. broadcast	120-150 lbs. N, split application, 60 lbs. P_2O_5 and 60 lbs. K_2O.
Sorghum-Sudan Hybrids	Commercially available varieties	April-June	15 lbs. in rows 35 lbs. broadcast	120 to 180 lbs. N in split applications; 60 lbs P_2O_5 60 lbs. K_2O.
COOL SEASON GRASS- LEGUME MIXTURES (ANNUAL OR TEMPORARY) [6/]				
Annual Ryegrass with one of the following	Gulf, Magnolia, Blends or (common in North Miss only)	Sept.-Nov.	25 lbs.	60-100 lbs. each of P_2O_5 and K_2O in a 1:1 ratio at seeding time.
Arrowleaf Clover[4/]	Meechee or Yuchi	Sept.-Nov.	10 lbs.	
Crimson Clover	Autauga, Chief, or Tibbee	Sept.-Nov.	20 lbs.	Same as above
Annual Ryegrass and wheat or oats	As above	Sept.-Nov.	25 lbs.	Same as Above
with legume (as with ryegrass)	See wheat and oats	Sept.-Nov.	90 lbs.	
Small Grains and Legume (Use same as with ryegrass	Oats, rye or wheat (See varieties under grass)	Sept.-Nov.	90 lbs. of small grain	Same as above.
COOL SEASON GRASS—LEGUME MIXTURES (PERMANENT)				
Tall Fescue or Orchardgrass[7/] (North Mississippi only) with	Alta, or Kentucky 31 Goar Commercial, Boone, or Jackson	Sept.-Nov.	10 lbs. in 20" rows	**Establishment:** 60 to 100 lbs. each of P_2O_5 and K_2O in a 1:1 ratio
		Sept.-Nov.	10 lbs	**Maintenance:** 40 to 60 lbs. each of P_2O_5 and K_2O in a 1:1 ratio.
White Clover	Regal, Merit or La. S-1	Sept.-Nov.	2-3 lbs.	

7/ Use of Orchardgrass in North Mississippi only.

ANNUAL COOL SEASON GRASSES AND SMALL GRAINS				
Annual Ryegrass	Gulf, Magnolia, or Florida Rust Resistant, (Common in North Miss only)	Sept Oct.	30 -40 lbs.	120 to 220 lbs of N, split fall and spring, 80 to 100 lbs P_2O_5 and 40 to 50 lbs. K_2O in a 2:1 ratio
Barley (Grain only	Harrison, (Barsoy.) Jefferson, Keowee or McNair 601	Oct -Nov	90 lbs.	10-20 lbs N, 30-40 lbs each of P_2O_5 and K_2O, at seeding. Topdress with 60 to 90 lbs N about March 1
Oats	(North) Coker 242, Coker 66-22 (South) McNair 76-22 and Fla. 501	For Forage Sept -Oct For Grain Oct -Nov	For Forage 120 lbs For Grain 90 lbs.	Same as Ryegrass Same as Barley, use lower rate
Rye	Abruzzi, Balboa, Elben, Explorer, or Vitagraze	For Forage: Same as Oats For grain Oct -Nov.	For Forage 120 lbs For Grain 90 lbs.	Same as Ryegrass Same as Barley
Wheat	Arthur, Arthur-71 Blueboy II, Coker 68-15 Holley McNair 2203 and 4823	Same as for Rye	For Forage 120 lbs. For Grain 90 lbs.	Same as Ryegrass 10-20 lbs N, 40 lbs each of P_2O_5 and K_2O at planting Topdress with 60 to 90 lbs N about March 1

LEGUMES[8]/

Alfalfa (Hay)	Florida 66, Delta, or Cody	Sept -Nov	15-25 lbs	**Establishment:** 120 to 160 lbs each of P_2O_5 and K_2O in a 1 1 ratio and 1 5 lbs boron. **Maintenance:** 60-80 lbs P_2O_5 and 180 to 240 lbs K_2O in a 1:3 ratio and add 1 lb. boron.
Arrowleaf Clover[4]/	Meechee or Yuchi	Sept -Oct	10 lbs	60 lbs each of P_2O_5 and K_2O in a 1:1 ratio. For seed production add 0 5 to 1 0 lb boron
Austrian Winter Peas	Commercial	Sept.-Oct.	50 lbs.	Same as for Arrowleaf Clover.
Crimson Clover	Autauga, Chief, or Tibbee	Sept.-Oct	20-30 lbs.	Same as for Arrowleaf Clover.
Lespedeza (Annual) Sericea (Perennial)	Climax, or Summit Serala, or Commercial	Feb.-April Feb.-June	25 lbs. 30 lbs.	Same as for Arrowleaf Clover.
Red Clover (Hay)	Orbit, Kenland or Chesapeake	Sept.-Nov. Mar.-Apr.	10 lbs.	**Establishment:** 60 to 100 lbs. each of P_2O_5 and K_2O in a 1 1 ratio. **Maintenance:** 50 lbs. P_2O_5 and 100 lbs K_2O in a 1:2 ratio.
Rough Pea	Commercial—also known as Singletary, Caley and Wild Winter peas	Sept.-Oct.	40 lbs.	Same as for Arrowleaf Clover.
Vetch	Warrior	Sept.-Oct.	30 lbs.	Same as for Arrowleaf Clover.
White Clover	Regal or Merit	Sept.-Nov.	2-3 lbs	Same as for Arrowleaf Clover.

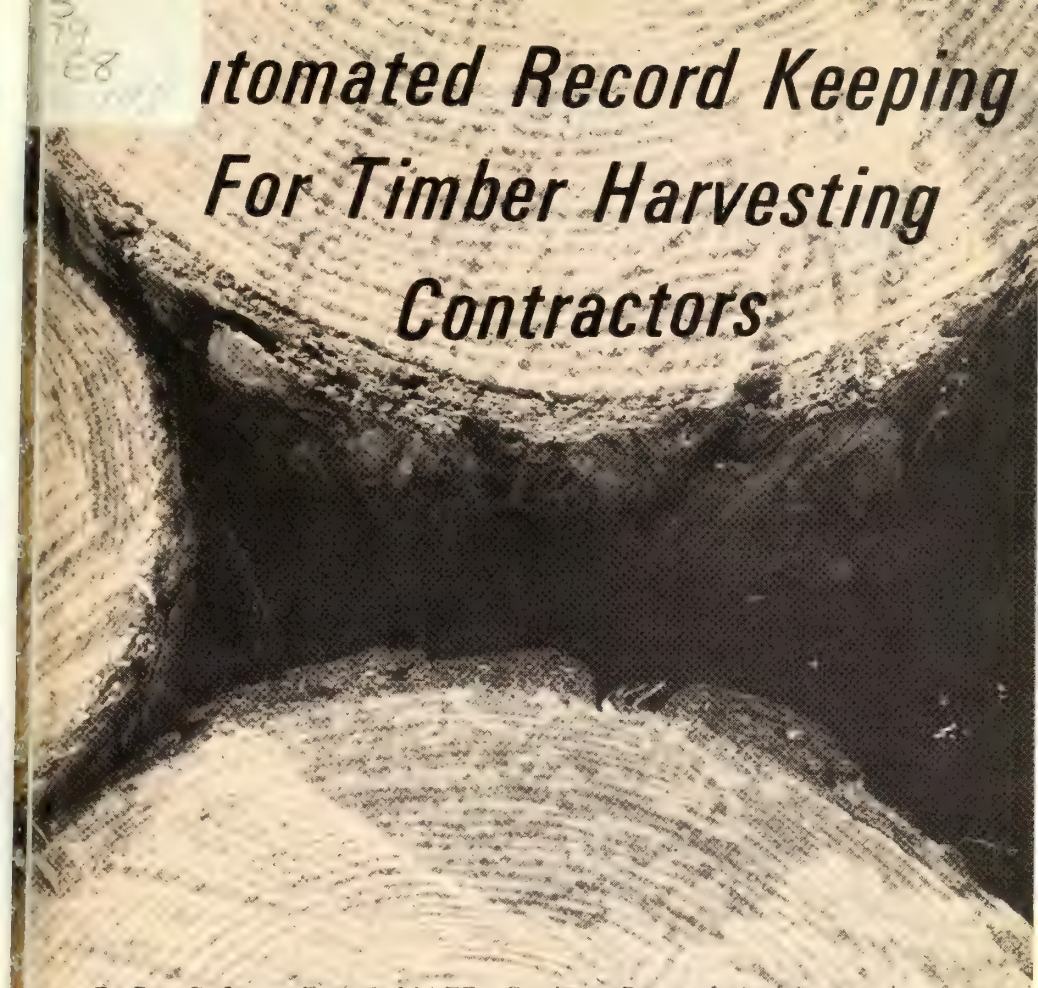
[8]/ **All legume seed should be inoculated with the proper culture immediately before planting.**

RECOMMENDATIONS FOR LAWNS AND SIMILAR TURF AREAS

Grass	Recommended Varieties	Method of Planting	Rate of Planting	Fertilization per 1000 Sq. ft. per Yr.[9/]
Bahiagrass	Pensacola or Wilmington	Seed	5-10 lbs./1000 sq. ft.	6 lbs. nitrogen 2 lbs. P_2O_5 4 lbs. K_2O split into 4 applications
Bermudagrass	Common	Seed	2 lbs./1000 sq. ft.	6-8 nitrogen 2 lbs. P_2O_5
	Tiflawn, Ormond, Tifway or Tifdwarf	Sprig or plug	Sprig or plug 6-12 ins. apart on 6-12 in. rows	3-4 lbs. K_2O, split into 4 applications
		Stolonize	2-5 bu./1000 sq. ft.	
Carpetgrass	Common	Seed	5 lb/1000 sq. ft.	2-3 lbs. nitrogen 1 lb. P_2O_5 1-2 lbs. K_2O, split into 2-3 applications
Centipedegrass	Common, or Oaklawn	Seed or	4 oz/1000 sq. ft.	Same as carpet
		Sprig or plug	Sprig or plug 6-12 ins. apart on 6-12 in. rows.	
Fescue	K-31	Seed	7-10 lbs./1000 sq. ft.	4 lbs. nitrogen (2 in fall, 2 in spring) 2 lbs. P_2O_5 and 4 lbs. K_2O
Ryegrass	Gulf, or Magnolia	Overseed permanent lawns	8-10 lb./1000 sq. ft	1 lb. nitrogen in January and March
St Augustinegrass	Common	Sprig or plug	Sprig or plug 6-12 ins. apart on 6-12 in. rows	Same as bahia
Zoysiagrass	Emerald, Matrella, or Meyer	Sprig or plug	Sprig or plug 6 ins. apart on 6 in. rows	Same as bahia

[9/] **When establishing a new lawn incorporate 2-3 lbs. of N; 4-6 lbs. of P_2O_5 and 2-3 lbs. of K_2O per 1000 sq. ft. into the seedbed prior to planting.**

ıtomated Record Keeping For Timber Harvesting Contractors



By Ben C. Jones, Former MAFES Graduate Research Assistant, and
R. Rodney Foil, MAFES Head of Department of Forestry

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MISSISSIPPI AGRICULTURAL & FORESTRY EXPERIMENT STATION
James H. Anderson, Director
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Automated Record Keeping

For Timber Harvesting Contractors

Introduction

During recent years, the business of rvesting timber has grown from small ›erations depending largely on family ›or and simple equipment to highly :chanized systems requiring skilled ›or and large investments. With this ange has come the need for more curate record keeping systems. This .per presents an automated system at should prove helpful in reducing ›sts and improving management :cisions.

The system is patterned after ccessful programs developed to help rmers cross the boundary from the mily farm to the highly mechanized ;ricultural business of today.

Agricultural agencies, notably the ›operative Extension Service, have ed this accounting system approach to crease farm productivity for a number years (Carville, 1966: NSCES, 1967). ırm record keeping systems were lapted to this method of processing at duced costs with increased utility. nese farm accounting systems provide ısic costs and management data, and addition, give each cooperator a atistical summary of cost experience ı all farms participating in the system.

Use of this technique in forestry has :en limited. Hartwig (1967) has orked with pulpwood producers in lichigan for several years, using an daptation of the Telefarm farm :counting system. Foil (1969) used a milar system in Louisiana in a limited ilot study.

Based on these prior experiences, this system which allows for several levels of sophistication in input and output data was developed. In all cases it provides for computation of major cost items such as labor, depreciation, interest, and repairs. The system is designed to be used by some sponsoring agency, private or governmental, to assist groups of harvesting contractors with their business affairs. This paper presents the type of input and output data used in the system, along with details of the supporting computer program. Emphasis is on cost factors only, with no regard for revenue and profit or loss computations.

The system is based on monthly reports that yield cost factors for the current month as well as the previous month and total costs for the year. Production reports are also available monthly.

These reports will be of benefit to the user since they are an accurate cost record of the logging operation. They may be used to locate high cost areas, provide a basis for machinery cost computations, provide records of a specific operation, and provide a record of the purchase of items such as safety equipment. They may also be used as a record of FICA and other labor associated costs.

Besides monthly reports, provision is made for quarterly and annual summaries.

Basic Data Requirements

Cooperating logging contractors should submit basic cost data on three types of forms. Capital outlay for equipment is reported on an Equipment Inventory Form, production data on a Production Data Form, and all other expenses are reported on a Daily Expense Form.

Daily Expense Form

General Information: The purpose of the Daily Expense Form is to tie the costs associated with each cash payment to the operation, machine, or individual responsible for the payment. The information taken from this form is used to make monthly and semi-annual reports of timber harvesting costs.

This accounting system has great flexibility so that an individual producer can obtain information in any detail desired. The computer program is written so as to allow a cooperator to tie each expenditure to any part or phase of his operation or to the overall operation in general. Costs may be associated with a specific employee or machine through proper use of codes.

Codes: The codes used in the Daily Expense Form are listed in Appendix I for the column in which they occur. For the most part the code titles are self-explanatory.

Use of the Daily Expense Form: Descriptive column headings for the Daily Expense Form are shown in Table 1. If detailed reports are not desired every column need not be used. The are, however, two columns (5 and which are essential to every report. No that the amount of each expenditure entered in the right-hand colum column 8. This column must be utiliz for all entries. The other essenti column, column 5, is the Major Expen column. The use of these two colum alone will provide sufficient i formation for the development of bas cost reports on an operation.

The Major Expense column is used t identify the source of the amount liste in column 8. Major Expense sources f column 5 are Labor, Repairs, Fue Lubricants-Filters, Taxes, Insuranc Hand-Tools, Miscellaneous Busine Expenses, Interest, and Non-Expen Hour Inputs. Each of these majo categories heads a series of codes whic can be used for detailed cost breal downs. For example, the 1000 seri (Labor) includes Wages (1300), FIC (1500), Workman's Compensatio (1600), and other associated labor cost Income Tax & Social Security (190 may be reported if net pay (gross pa minus deductions) is reported in th Regular and/or Overtime categories.

The first code in each series is th major heading for that series and shoul be used if detailed reports are nc desired. Taking the Labor series as a example, labor costs may be broke down into their various categories or th entire sum may be simply charged t Labor. Code 1000 is titled Labor and i

Table 1. Sample Headings, Daily Expense Form

(1) Location	(2) Job	(3) Type	(4) Phase	(5) Major Expense	(6) Hours Involved	(7) Description	(8) Amount

t major heading for the Labor series. It is not desirable to break the cost of or into its component parts such as gular Wages (1300), Overtime Wages 400), and/or FICA (1500) then labor sts should be recorded by placing 00 in column 5.

To associate labor or machinery costs th any specific employee or machine o digit codes are provided which ould be entered as the right-hand gits of the Major Expense code with nich they are associated.

The remaining columns are optional, t may be used to identify a specific ging chance. Each chance may be orded as a two digit code of the user's osing. A suggestion for forming this de is to let the first digit represent a ecific county and the second digit a ecific location within that county. ing zero as the first right-hand digit ows the identification of ten locations thin any one county and ten counties. listing of location codes is found on ge 23 of Appendix 1. These same des are used later on the Production ata Form.

Costs may be associated with a ecific harvesting enterprise (job) such pulpwood, sawtimber or pole and ling by placing the appropriate code , 2, or 3, respectively) in column 2.

If the user desires to associate costs th a specific type of operation within ch job, column 3 is used to indicate the ecific type. The types of operations ecified in Appendix 1 are pine, hard- ood, and mixed, with options as to the ethod of logging—either longwood or ortwood.

In column 4 costs may be associated ith a specific phase of the overall peration. The phases provided for in olumn 4 are felling, skidding, loading, auling, and transporting.

Column 6 is used to record hours orked on a daily or weekly basis. Records may be kept on the number of hours worked on a particular phase, type, or job. This record requires that the 9000 series code be used in column 5 and labor hours be reported in column 6. For this record no entry should be made in column 8.

The last of the columns which are provided for optional entries is column 7. This column is provided for written descriptions of the coded transactions but an entry in this column is not essential to any reports. Entries may be made here, however, to aid personnel at the computer center in the verification of coded entries.

Sample Cost Entry: Table 2 is an example of the use of coding to identify costs in varying detail. Entries one through five in Table 2, page 4, are for the same transaction of $65.00 paid to an employee. Each succeeding entry shows how this cost might be coded yielding more information concerning the cost in each step. Entries 6 and 7 involve the 9000 series code. This series is for information other than costs.

In Entry 1 placing two digits in column 1 establishes the location of the operation and the $65.00 cost is associated with this location. If the column is left blank, the $65.00 cost of labor is assigned to the overall costs of the business but not to a specific job. No code in column 3 and 4 indicates that a breakdown is not desired as to the type of operation and that a cost report on the basis of the various phases of operation is not desired. In column 5, the code number 1000 represents the major expense labor. This is the overall labor expense without breakdown as to the categories of labor costs such as Wages or FICA and does not specify any particular individual. Column 6 is used with the 9000 code only and is left blank in this case. In column 7 there is a short description of the expenditure and

Table 2. Cost Reporting Example

Mississippi State University
Department of Forestry
Cost Accounting Project
Form Type 1

Producer ID 587055723

Reporting Period 170172 To 240172

Daily Expense Form

Name John Doe

Address 111 St. James Street

McComb, MS 39648

Entry	(1) Location	(2) Job	(3) Type	(4) Phase	(5) Major Expense	(6) Hours Involved	(7) Description	(8) Amount
1	10				1000		Paid 1 week's wages	65.00
2	10	1			1000			65.00
3	10	1	2		1000			65.00
4	10	1	2		1010			65.00
	10	1	2		1310			61.00
5	10	1	2		1410			4.00
6	10	1	2	1	9000	14.0		

column 8 we find the amount.

Example entry 2 is the same as ample entry 1 for all columns except lumn 2. Code number 1, the code for lpwood, has been placed in column 2. ie $65.00 will now be attributed to bor associated with a pulpwood job.

In entry 3 the code number 2, which presents a pine longwood operation, is ded to column 3. Thus the costs of bor are now associated with the rticular type of operation in which the st occurred.

The two right-hand digits of the ajor expense codes in example entry 4 e replaced with the new code 10. These wo digits are taken from page 22 of ppendix 1 and represent a specific nployee. Thus, among other facts we now to whom the labor cost of $65.00 as paid.

Entry 5 is in two steps. Taking the me $65.00 as in the above examples, it specified in its various labor tegories. Code 1300 and code 1400 of e labor series are used to accomplish is. Regular Wages (1300) account for 51.00 of the employee's pay. Overtime ages (1400) account for the remaining $4.00 of the employee's $65.00 in pay.

In example entries 6 and 7, the 9000 series code is used. Entry 6 records hours of labor utilized in the felling phase and entry 7 records labor hours involved in skidding. These daily work records enable hours to be associated with the appropriate area of operation.

Entries 1 through 5 in the example show how the cost can be recorded six different ways depending on the amount of information given. Since the reports can only reflect the information given, the more the user breaks costs into its various parts, the better the information will be that is returned on the reports and the greater the utility the reports will have for management decision making.

Equipment Inventory Form

Fixed costs associated with owning equipment are computed from information provided on the Equipment Inventory Form. When a cooperator joins the program he should complete one form for each piece of equipment. The data provided permit the calculation of depreciation rates,

able 3. Sample Headings, Equipment Inventory Form

orm Number
roducer ID
ate of Purchase
quipment ID
urchase Price
epreciation Method
seful Life
xpected Salvage Value
nterest Rate
nsurance
axes
lumber of Payments
ear of Manufacture
lonths Between Payments
mount of Payment
mount Borrowed
Comments

machine rates, and interest expenses.

After the initial equipment inventory is completed, any changes in inventory are reported as they occur. Disposal of any equipment previously on record is reported as "removed from inventory".

Information needs for the Equipment Inventory Form, Table 3, may be developed from several sources. Equipment Identification numbers are selected by the producer from page 22 of the Appendix, while the user's social security number or employee's identification number is employed as the Producer Identification. These numbers insure that a duplication of identification does not occur.

Prior experience is the key to the estimation of the years of useful life and expected salvage value for each piece of equipment. Where the user lacks experience, dealers or other contractors may be helpful.

The remaining information can be taken from documents relating to the equipment purchase. The Bill of Sale provides such data as the date of purchase, purchase price, and the year of manufacture. If a loan is used to finance the equipment the financing company or loan papers supply the information necessary to calculate interest costs. Essential information is the amount borrowed, amount of each payment, number of payments, interest rate, and months between payments.

Yearly tax and insurance costs are located among the user's payment receipts or premium notices. The user's insurance agent and the county tax assessor may be helpful here.

One of the major costs related to equipment ownership and operation is depreciation. Depreciation is a cost equal to the declining value of equipment due to use and obsolesence. It is a legitimate cost of operation which may be deducted from income before taxes. The Equipment Inventory Form allows for the use of one of three methods of calculating depreciation. The first method, straight line, charges an equal amount yearly as a cost of operation. The other two methods which are available are sum-of-the-years digits and declining balance. Both of these methods charge higher costs in the first few years of ownership and lower rates later in the life of the equipment. Since these two methods take the time value of money into consideration, they are often preferred for income tax purposes.

Production Data Form

The Production Data Form (Table 4) as its name implies, is used to record timber production. Complete utilization of the form results in a record of production for each specific harvesting operation and product type, including a record of haul miles and other mileage associated with the harvesting operation.

Column headings on the Production Data Form are self-explanatory with the exception of column 2. This column is used to identify specific types of production by product and logging method. The fourteen available identification codes are listed on page 24 of Appendix 1.

Table 4. Sample Headings, Production Data Form

(1) Location	(2) Prod Type	(3) Units Produced	(4) Hauling Distance Round Trip	(5) Number of Round Trips	(6) Pick-up Miles	(7) Nam of Trac

e only section of the Production Form which is required for proper ation of the system is column 3, s Produced; however, use of the th columns provides data which can sed in association with the cost ds developed from the Daily ense Form and the Equipment ntory Form. Haul miles and product type information gathered from the Production Form enable the producer to calculate unit costs per haul mile by product type.

Expenditures for Producer 640350095 Loc O Sawtimber Pine Long

Phase	Expenses This Month	Last Month	Yr. to Date	Hours This Month	Last Month	Yr. to Date
General						
Regular Pay	439.65	4104.36	4544.01	.00	.00	.00
Overtime	120.65	819.79	940.44	.00	.00	.00
FICA	29.12	253.62	282.74	.00	.00	.00
Income Tax	43.60	43.60	87.20	.00	.00	.00
Repairs	22.85	22.85	45.70	.00	.00	.00
R Rep Parts	254.09	254.09	508.18	.00	.00	.00
Lubricants	16.08	16.08	32.16	.00	.00	.00
Hand Tools	26.60	54.96	81.56	.00	.00	.00
Mis. Bus Exp.	4.80	20.40	25.20	.00	.00	.00
Labor Hrs.	.00	.00	.00	500.00	1000.00	1500.00
Total	957.44	5589.75	6547.19	500.00	1000.00	1500.00
Felling Buck						
Repairs	6.05	6.05	12.10	.00	.00	.00
R Rep. Parts	139.98	151.74	291.72	.00	.00	.00
Total	146.03	157.79	303.82	.00	.00	.00
Skidding						
Repairs	.00	621.48	621.48	.00	.00	.00
R Rep. Parts	.00	2.63	2.63	.00	.00	.00
Lubricants	11.50	17.90	29.40	.00	.00	.00
Filters	5.20	5.20	10.40	.00	.00	.00
Total	16.70	647.21	663.91	.00	.00	.00
Loading						
R Rep Parts	11.15	89.62	100.7/	.00	.00	.00
Lubricants	5.32	5.32	10.64	.00	.00	.00
Filters	2.60	2.60	5.20	.00	.00	.00
Total	19.07	97.54	116.61	.00	.00	.00
Hauling						
Repairs	161.15	161.15	322.30	.00	.00	.00
R Rep. Parts	33.65	67.25	100.90	.00	.00	.00
C Rep. Labor	.00	194.88	194.88	.00	.00	.00
Lubricants	.00	16.00	16.00	.00	.00	.00

Reports: Utilizing the data submitted on the Daily Expense, Production, and Equipment Inventory Forms, the computer program develops five reports which show cost and production figures. These reports provide a concise view of the cost structure of any harvesting business.

Expenditures for Producer Report: The Expenditures for Producer Report, Table 5, is derived from the Daily Expense Form. This table yields all variable costs and fixed costs not associated with machinery. Costs are categorized by location, by each product category within that location,

Table 5. (continued)

Expenditures for Producer 640350095 Loc 1 Sawtimber Pine Long

Phase	Expenses This Month	Last Month	Yr. to Date	Hours This Month	Last Month	Yr. to Date
General						
Filters	.00	18.76	18.76	.00	.00	.00
Total	194.80	458.04	652.84	.00	.00	.00
Transport						
Repairs	.00	11.70	11.70	.00	.00	.00
R Rep. Parts	.00	7.81	7.81	.00	.00	.00
Fuel	.00	8.93	8.93	.00	.00	.00
Lubricants	1.54	1.54	3.08	.00	.00	.00
Filters	9.34	9.34	18.68	.00	.00	.00
Total	10.88	39.32	50.20	.00	.00	.00
Total	1344.92	6989.65	8334.57	500.00	1000.00	1500.00
Fuel	.96	.96	1.92	.00	.00	.00
Felling Buck						
Fuel	10.00	10.00	20.00	.00	.00	.00
Skidding						
Repairs	*130.40	130.40	260.80	.00	.00	.00
R Rep. Parts	176.65	176.65	353.30	.00	.00	.00
Fuel	5.76	30.48	36.24	.00	.00	.00
Filters	.00	5.46	5.46	.00	.00	.00
Total	312.81	342.99	655.80	.00	.00	.00
Loading						
Fuel	1.68	1.68	3.36	.00	.00	.00
Hauling						
Repairs	.00	66.15	66.15	.00	.00	.00
Fuel	10.91	27.98	38.89	.00	.00	.00
Lubricants	10.24	10.24	20.48	.00	.00	.00
Total	21.15	104.37	125.52	.00	.00	.00
Transport						
Repairs	.00	29.32	29.32	.00	.00	.00
Fuel	4.18	11.05	15.23	.00	.00	.00
Filters	6.93	6.93	13.86	.00	.00	.00
Total	11.11	47.30	58.41	.00	.00	.00
Total	357.71	507.30	865.01	.00	.00	.00

ınd by each harvesting phase within that ocation and product category. In ıddition, labor or machine hours are eported thus allowing the user to alculate production costs per hour. Hours and costs for the current month are compared with the preceding month. Total figures for year-to-date are provided.

Phase	Expenses This Month	Last Month	Yr. to Date	Hours This Month	Last Month	Yr. to Date
General						
Labor Hrs.	.00	.00	.00	400.00	900.00	1300.00
Felling Buck						
Fuel	4.00	10.00	14.00	.00	.00	.00
Skidding						
Fuel	9.60	20.16	29.76	.00	.00	.00
Loading						
Fuel	1.08	1.08	2.16	.00	.00	.00
Hauling						
Fuel	18.09	18.09	36.18	.00	.00	.00
Labor Hrs.	.00	.00	.00	60.00	160.00	220.00
Total	18.09	18.09	36.18	60.00	160.00	220.00
Transport						
Fuel	6.71	6.71	13.42	.00	.00	.00
Total	39.48	56.04	95.52	460.00	1060.00	1520.00

Expenditures for Producer 640350095 Loc 3 Sawtimber Pine Long

Phase	Expenses This Month	Last Month	Yr. To Date	Hours This Month	Last Month	Yr. to Date
Loading						
Fuel	.96	.96	1.92	.00	.00	.00
Hauling						
Fuel	11.39	17.10	28.49	.00	.00	.00
Total	12.35	18.06	30.41	.00	.00	.00

Expenditures for Producer 640350095 Loc 4 Sawtimber Pine Long

Phase	Expenses This Month	Last Month	Yr to Date	Hours This Month	Last Month	Yr. to Date
General						
Fuel	13.18	16.78	29.96	.00	.00	.00
Felling Buck						

Table 5. (continued)

Expenditures for Producer 640350095 Loc 4 Sawtimber Pine Long

Phase	Expenses This Month	Last Month	Yr. to Date	Hours This Month	Last Month	Yr. to Date
Fuel	8.00	22.00	30.00	.00	.00	.00
Skidding						
Fuel	11.52	39.68	51.20	.00	.00	.00
Lubricants	.00	6.40	6.40	.00	.00	.00
Total	11.52	46.08	57.60	.00	.00	.00
Loading						
Fuel	15.82	41.10	56.92	.00	.00	.00
Hauling						
R Rep Parts	3.62	3.62	7.24	.00	.00	.00
Fuel	26.95	383.95	410.90	.00	.00	.00
Total	30.57	387.57	418.14	.00	.00	.00
Transport						
Fuel	18.85	72.19	91.04	.00	.00	.00
Total	97.94	585.72	683.66	.00	.00	.00

Expenditures for Producer 640350095 Loc 5 Sawtimber Pine Long

Phase	Expenses This Month	Last Month	Yr. to Date	Hours This Month	Last Month	Yr to Date
General						
Fuel	5.24	8.68	13.92	.00	.00	.00
Repairs	.00	1.83	1.83	.00	.00	.00
Fuel	.00	8.88	8.88	.00	.00	.00
Total	5.24	19.39	24.63	.00	.00	.00
Felling Buck						
Fuel	6.00	20.00	26.00	.00	.00	.00
Skidding						

Table 5. (continued)

Expenditures for Producers 640350095 Loc 5 Sawtimber Pine Long

Fuel	5.28	38.82	44.10	.00	.00	.00
Filters	.00	2.60	2.60	.00	.00	.00
Total	5.28	41.42	46.70	.00	.00	.00
Loading						
Fuel	2.76	4.80	7.56	.00	.00	.00
Hauling						
Fuel	30.25	142.82	173.07	.00	.00	.00
Transport						
Fuel	1.91	25.35	27.26	.00	.00	.00
Total	51.44	253.78	305.22	.00	.00	.00

Expenditures for Producer 640350095 Loc 6 Sawtimber Pine Long

Phase	*Expenses This Month*	*Last Month*	*Yr to Date*	*Hours This Month*	*Last Month*	*Yr to Date*
General						
Mis. Bus Exp	.00	40	.40	.00	.00	.00
Felling Buck						
Fuel	.00	50	.50	.00	.00	.00
Loading						
Fuel	00	48	48	00	00	00
Hauling						
Fuel	00	5.91	5.91	00	00	00
Transport						
Fuel	00	16.16	16.16	00	00	00
Total	00	23.45	23.45	00	00	00

Expenditures for Producer 640350095 Loc 7 Sawtimber Pine Long

Phase	*Expenses This Month*	*Last Month*	*Yr to Date*	*Hours This Month*	*Last Month*	*Yr to Date*
Felling Buck						
Fuel	00	2.00	2.00	2.00	00	.00
Skidding						
Fuel	8.64	14.24	22.88	00	.00	.00
Transport						
Fuel	61	1.25	1.86	.00	.00	.00
Total	9.25	17.49	26.74	.00	.00	.00
Total	1913.09	8451.49	10364.58	960.00	2060.00	3020.00

Major Expenditures for Producer Report: Major Expenditures for Producer, Table 6 page 12, lists in coded form all individual entries from the Daily Expense Form sorted into various cost categories and locations. Individual costs are listed for the current and previous month with totals for year-to-date. This record provides the user with a means for rapid referral on any prior cost. The year-to-date column provides the user with, among other costs, accurate annual labor co records on each employee. This reco proves invaluable in dealing wi current federal labor requirements.

Table 6. Major Expenditures for Producer Report

Maj. Exp.	This Month	Last Month	Year to Dat
1301	204.20	204.20	408.4(
1302	235.45	235.45	470.9(
1303	.00	240.55	240.5
1304	.00	270.30	270.3(
1310	.00	138.60	138.6(
1311	.00	214.50	214.5(
1312	.00	214.50	214.5(
1313	.00	218.80	218.8(
1314	.00	211.20	211.2(
1320	.00	531.20	531.2(
1325	.00	272.00	272.0(
1331	.00	265.20	265.2(
1332	.00	220.23	220.2
1335	.00	226.05	226.0
1350	.00	222.05	222.0
1351	.00	140.60	140.6(
1352	.00	216.23	216.23
1353	.00	62.70	62.70
1401	62.00	62.00	124.00
1402	58.65	58.65	117.30
1403	.00	58.65	58.65
1404	.00	102.00	102.00
1410	.00	.00	.00
1412	.00	26.40	26.40
1413	.00	22.95	22.95
1414	.00	17.36	17.36
1420	.00	99.60	99.60
1425	.00	134.40	134.40
1431	.00	76.20	76.20
1432	.00	34.72	34.72
1435	.00	32.24	32.24
1450	.00	54.56	54.56
1451	.00	10.40	10.40
1452	.00	26.40	26.40
1453	.00	3.26	3.26
1501	13.83	13.83	27.66
1502	15.29	15.29	30.58
1503	.00	15.56	15.56
1504	.00	19.36	19.36

Table 6. (continued)

Maj. Exp.	This Month	Last Month	Year To Date
1510	.00	7.20	7.20
1511	.00	13.76	13.76
1512	.00	12.52	12.52
1513	.00	12.58	12.58
1514	.00	11.88	11.88
1520	.00	32.80	32.80
1525	.00	20.32	20.32
1531	.00	17.03	17.03
1532	.00	13.26	13.26
1535	.00	13.43	13.43
1550	.00	14.35	14.35
1551	.00	7.85	7.85
1552	.00	12.60	12.60
1925	43.60	43.60	87.20
2001	161.55	161.55	323.10
2002	3.02	71.00	74.02
2020	3.86	3.86	7.72
2140	24.03	24.03	48.06
2152	230.06	230.06	460.12
3201	26.32	26.32	52.64
6000	26.60	54.96	81.56
7000	4.80	20.80	25.60
9000	.00	.00	.00
2032	6.05	6.05	12.10
2130	49.87	49.87	99.74
2131	24.76	24.76	49.52
2135	65.35	77.11	142.46
2011	98.64	720.12	818.76
2110	.00	1.32	1.32
2111	.00	1.31	1.31
3210	.00	6.40	6.40
3213	5.10	5.10	10.20
3214	6.40	6.40	12.80
3310	2.60	2.60	5.20
3314	2.60	2.60	5.20
2120	11.15	89.62	100.77
3221	5.32	5.32	10.64
3321	2.60	2.60	5.20
2004	15.57	15.57	31.14
2100	6.80	6.80	13.60
2101	183.47	183.47	366.94
2102	23.65	23.65	47.30
2103	.00	12.07	12.07
2104	.00	21.53	21.53
2501	.00	194.88	194.88
3202	00	3.20	3.20
3203	.00	12.80	12.80
3301	.00	10.03	10.03
3302	.00	4.16	4.16
3303	.00	7.30	7.30
2044	31.76	35.06	66.82
2045	00	37.72	37.72
2144	.00	7.81	7.81
3144	4.56	32.13	36.69
3242	1.54	1.54	3.08
3342	16.27	16.27	32.54
3140	4.32	24.72	29.04
3139	32.00	72.50	104.50
3111	6.24	29.52	35.76

3113	.00	25.98	25.
3114	8.40	36.72	45.
3311	.00	5.33	5
3121	8.52	18.24	26
3101	58.02	133.02	191.
3102	34.19	226.27	260.
3103	7.54	217.19	224.
3120	17.97	50.51	68.
3142	26.54	86.31	112.
3110	11.76	19.20	30.
3112	15.60	28.20	43.
3141	4.67	7.47	12.
3211	.00	6.40	6.
3104	.00	18.17	18.
3143	.00	4.62	4.
Total	1913.09	8451.49	10364.

Production for Producer Report: Production for Producer, shown in Table 7, summarizes the production for each location and product category. Production for Producer also yields information pertaining to mileage associated with the harvesting operation allowing the user to calculate production cost per mile.

Table 7. Production for Producer Report

	This Month	*Last Month*	*Year to D*
Location 1			
Saw P-Long	70929.00	100264.00	171193
Miles Traveled			
Haul-Miles	384.00	594.00	97
Pick-Up	.00	.00	
Location 2			
Saw P-Long	15489.00	15489.00	30978
Miles Traveled			
Haul-Miles	248.00	248.00	496
Pick-Up	.00	.00	
Location 3			
Saw P-Long	12403.00	12403.00	24806
Miles Traveled			
Haul-Miles	90.00	90.00	180
Pick-up	.00	.00	
Location 4			
Saw P-Long	40401.00	173500.00	213901
Miles Traveled			
Haul-Miles	1116.00	4836.00	5952.
Pick-Up	.00	.00	
Location 5			
Saw P-Long	28960.00	187450.00	216410.
Miles Traveled			
Haul-Miles	111.00	1933.00	2044.
Pick-Up	.00	.00	
Location 6			
Saw P-Long	.00	12000.00	12000.
Miles Traveled			
Haul-Miles	.00	440.00	440.
Pick-Up	.00	.00	

Equipment Expenses Report: Table 8, Equipment Expenses, is extremely useful since equipment costs are of such vital importance to harvesting contractors. The equipment cost report contains some items listed on the expenditure report, along with additional fixed costs. For each piece of equipment, taxes, depreciation, interest, insurance, repairs and supply costs are reported for the current period, the previous period, and the entire year. In addition, total operating cost for each machine and the total equipment inventory is summarized by reporting period.

Table 8. Equipment Expenses Report

Equipment Expenses
This Month

Equip.	Taxes	Deprec.	Interest	Insurance	Maj. Rep.	Fuel	Total
0	.00	.00	.00	.00	6.80	.00	6.80
1	.00	96.50	.00	52.00	345.02	84.34	577.86
2	10.42	302.05	.00	60.67	27.67	34.19	434.19
3	10.42	761.67	.00	67.92	.00	7.54	847.54
4	12.00	761.67	.00	.00	15.57	.00	789.24
6	12.00	42.67	.00	.00	.00	.00	54.67
8	16.67	64.78	.00	.00	.00	.00	81.45
10	16.67	.00	.00	17.71	.00	14.36	48.73
11	.00	100.40	.00	17.71	98.64	6.24	222.99
12	.00	286.42	.00	31.25	.00	15.60	333.27
13	10.42	257.50	18.48	12.50	.00	5.10	304.00
14	12.00	633.33	113.19	17.71	.00	17.40	793.63
20	12.00	.00	.00	7.17	15.01	17.97	52.15
21	16.67	815.27	72.95	.00	.00	16.44	921.32
30	.00	.00	.00	.00	49.87	.00	49.87
31	.00	.00	.00	.00	24.76	.00	24.76
32	.00	.00	.00	.00	6.05	.00	6.05
35	.00	.00	.00	.00	65.35	.00	65.35
39	.00	.00	.00	.00	.00	32.00	32.00
40	16.67	129.17	.00	27.08	24.03	4.32	201.27
41	20.83	79.39	.00	20.00	.00	4.67	124.89
42	.00	71.45	.00	17.42	.00	44.35	133.22
43	10.83	.00	.00	17.25	.00	.00	28.08
44	7.50	38.32	.00	32.33	31.76	4.56	114.47
45	20.00	15.00	.00	13.08	.00	.00	48.08
46	12.50	6.55	.00	.00	.00	.00	19.05
52	.00	.00	.00	.00	230.06	.00	230.06
Total	217.58	4462.32	204.62	411.79	939.59	309.08	6544.99

Table 8 (continued)

Equipment Expenses
Last Month

Equip.	*Taxes*	*Deprec.*	*Interest*	*Insurance*	*Maj. Rep.*	*Fuel*	*Total*
0	.00	.00	.00	.00	6.80	.00	6.80
1	.00	96.50	.00	52.00	539.90	169.37	857.77
2	10.42	302.25	.00	60.67	94.65	233.63	701.61
3	10.42	761.67	.00	67.92	12.07	237.29	1089.36
4	12.00	761.67	170.87	.00	37.10	17.18	999.80
6	12.00	42.67	.00	.00	00	.00	54.67
8	16.67	77.74	.00	.00	.00	.00	94.40
10	16.67	00	.00	17.71	1.32	28.20	63.89
11	.00	100.40	.00	17.71	721.43	41.25	880 79
12	.00	286 42	.00	31.25	.00	28.20	345.87
13	10.42	257.50	21.04	12.50	.00	31.08	332.54
14	12.00	633.33	119.03	17.71	.00	45.72	827.80
20	12.00	.00	.00	7.17	93.48	50.51	163.16
21	16.67	815.27	76.31	.00	.00	26.16	934.40
30	.00	.00	.00	.00	49.87	.00	49.87
31	.00	.00	.00	.00	24.76	.00	24.76
32	.00	.00	.00	.00	6.05	.00	6.05
35	.00	.00	.00	.00	77.11	.00	77.11
39	.00	.00	.00	.00	.00	72.50	72.50
40	16.67	129.17	.00	27.08	24.03	24.72	221.67
41	20.83	79.39	.00	20.00	.00	7.47	127.69
42	.00	71.45	.00	17.42	.00	104.12	192.99
43	10.83	.00	.00	17.25	.00	4.62	32.70
44	7.50	38.32	.00	32.33	42.87	32.13	153.15
45	20.00	15.00	.00	13.08	37.72	.00	85.80
46	12.50	6.55	.00	.00	.00	.00	19.05
52	.00	.00	.00	.00	230.06	.00	230.06
Total	217.58	4475.28	387.25	411.79	1999.22	1155.14	8646.26

Table 8 (continued)

Equipment Expenses Year to Date

Equip.	Taxes	Deprec.	Interest	Insurance	Maj. Rep.	Fuel	Total
0	.00	.00	.00	.00	13.60	.00	13.60
1	.00	193.00	.00	104.00	884.92	253.71	1435.63
2	20.83	604.50	.00	121.33	121.32	267.82	1135.81
3	20.83	1523.33	.00	135.83	12.07	244.83	1936.90
4	24.00	1523.33	170.87	.00	52.67	18.17	1789.04
6	24.00	85.33	.00	.00	.00	.00	109.33
8	33.33	142.52	.00	.00	.00	.00	175.85
10	33.33	.00	.00	35.42	1.32	42.56	112.63
11	.00	200.80	.00	35.42	820.07	47.49	1103.78
12	.00	572.83	.00	62.50	.00	43.80	679.13
13	20.83	515.00	39.52	25.00	.00	36.18	636.54
14	24.00	1266.67	232.23	35.42	.00	63.12	1621.43
20	24.00	.00	.00	14.33	108.49	68.48	215.30
21	33.33	1630.53	149.26	.00	.00	42.60	1855.73
30	.00	.00	.00	.00	99.74	.00	99.74
31	.00	.00	.00	.00	49.52	.00	49.52
32	.00	.00	.00	.00	12.10	.00	12.10
35	.00	.00	.00	.00	142.46	.00	142.46
39	.00	.00	.00	.00	.00	104.50	104 50
40	33.33	258.33	.00	54.17	48.06	29.04	422.93
41	41 67	158.78	.00	40.00	.00	12.14	252.58
42	.00	142.90	.00	34.83	.00	148.47	326.20
43	21.67	.00	.00	34.50	.00	4.62	60.79
44	15.00	76.63	.00	64.67	74.63	36.69	267.62
45	40.00	30.00	.00	26.17	37.72	.00	133.89
46	25.00	13.10	.00	.00	.00	.00	38.10
52	00	.00	.00	.00	460.12	.00	460.12
Total	435.17	8937.60	591.88	823.58	2938.81	1464.22	15191.25

Total Expenses Report: The final report, Total Expenses (Table 9) is a summary table containing totals for all major variable and fixed cost items along with the total production of forest products. Both cost and production figures are presented for the current month, the previous month, and the entire year.

Summary

Mechanization of harvesting operations and some federal labor requirements have brought about accounting burdens which are alien to most contractors. High costs associated with the mechanized harvesting systems currently in use have made it essential that a cost accounting system be developed that is structured to the needs of these producers.

This computerized system requires the user to submit data on three forms. Appendix 1 on page 2 contains detailed instructions for using these forms. The source program was written in FORTRAN IV for use on the UNIVAC 1106 computer with Exec 8 control system. The program is located in Appendix 2.

Comment statements are supplie within the program at points of majc interest and explain the fields for key punching data cards and aid in under standing computational procedures.

Literature Cited

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Foil, R. Rodney. 1969. Automate Bookkeeping for Timber Producers Proceedings. L.S.U. —A.P.A. Timbe Harvesting Shortcourse, Baton Rouge La. 16 pp.

Hartwig, R.T. 1967. Progress Repor on Electronic Record Keeping for Pulp wood Producers. Proceedings, Lak States Technical Division, Americai Pulpwood Association. Houghton Mich. 2 pp.

NESCES. 1967. ELFAC Instructior Manual. Northeastern State Cooperative Extension Services Bangor, Maine. 33pp.

Table 9. Total Expenses Report

Total Expenses	*This Month*	*Last Month*	*Yr. to Date*
Labor	633.02	5221.37	5854.39
Major Repair	939.59	1999.22	2938.81
Fuel-Lub-Fil	309.08	1155.14	1464.22
Taxes	217.58	217.58	435.17
Insurance	411.79	411.79	823.58
Hand Tools	26.60	54.96	81.56
Misc. Bus.Exp.	4.80	20.80	25.60
Interest	204.62	387.25	591.88
Depreciation	4462.32	4475.28	8937.60
Total	7209.41	13943.39	21152.80
Total Production			
Saw P-Long	168182.00	501106.00	669288.00

Appendix 1

Codes, Forms, and Instructions for Use in the Preparation of the Daily Expense Form, Equipment Inventory Form, and Production Data Form

Codes for Daily Expense Form

Column 1

Code	Location
Any two digit code you desire	

Column 2

Code	Job
0	General Cost of Operation
1	Pulpwood
2	Sawtimber
3	Pole and Piling

Column 3

Code	Type Operation
0	General Cost of Operation
1	Pine Shortwood
2	Pine Longwood
3	Hardwood Longwood
4	Hardwood Longwood
5	Mixed Shortwood
6	Mixed Longwood

Column 4

Code	Phase of Operation
0	General Cost of Operation
1	Felling, Limbing, Bucking
2	Skidding
3	Loading
4	Hauling
5	Transporting

Column 5

Code	Major Expense
1000	Labor (Total)
1300	Regular Wages
1400	Overtime Wages
1500	FICA(Employer's Contribution)
1600	Workman's Compensation
1700	Unemployment Compensation
1800	Other Labor Fringes
1900[1]	Income Tax & Social Security Withheld
2000	Repairs(Total)
2100	Routine Repairs (Parts)
2200	Routine Repairs (Labor)
2300	Routine Repairs (Total)
2400	Contracted Repairs (Parts)
2500	Contracted Repairs (Labor)
2600	Contracted Repairs (Total)
3000	Fuel, Lubricants, Filters
3100	Fuel
3200	Lubricants
3300	Filters
4000	Taxes
4100	Sales Tax
5000[1]	Insurance
6000	Hand-Tools, Miscellaneous Supplies
7000	Miscellaneous Business Expenses
8000	Interest (Loans)
8100	Interest (Machinery)

Column 5 (Continued)

9000	Non-Expense Labor Hours
9100	Non-Expense Machine Hours

[1]**The 1000-1900 codes in Column 5 may be tied to a specific employee by coding 01-99 in the two right columns. The codes 2000-5000 in Column 5 may be tied to a specific piece of machinery by coding 01-99 in the two right columns.**

Location Codes for Use on the Daily Expense Form And Production Data Form

Location	Location	Location	Location
01	26	51	76
02	27	52	77
03	28	53	78
04	29	54	79
05	30	55	80
06	31	56	81
07	32	57	82
08	33	58	83
09	34	59	84
10	35	60	85
11	36	61	86
12	37	62	87
13	38	63	88
14	39	64	89
15	40	65	90
16	41	66	91
17	42	67	92
18	43	68	93
19	44	69	94
20	45	70	95
21	46	71	96
22	47	72	97
23	48	73	98
24	49	74	99
25	50	75	

Product Category Codes for Column 2 of the Production Data Form

00 or Blank	
11	Pulpwood Pine Shortwood
12	Pulpwood Pine Longwood
13	Pulpwood Hardwood Shortwood
14	Pulpwood Hardwood Longwood
15	Pulpwood Mixed Shortwood
16	Pulpwood Mixed Longwood
21	Sawtimber Pine Shortwood
22	Sawtimber Pine Longwood
23	Sawtimber Hardwood Shortwood
24	Sawtimber Hardwood Longwood
25	Sawtimber Mixed Shortwood
26	Sawtimber Mixed Longwood
30	Pole and Piling

Right-Hand Digits for Column 5 of Daily Expense Form

Employee	Employee	Employee
01	34	67
02	35	68
03	36	69
04	37	70
05	38	71
06	39	72
07	40	73
08	41	74
09	42	75
10	43	76
11	44	77
12	45	78
13	46	79
14	47	80
15	48	81
16	49	82
17	50	83
18	51	84
19	52	85
20	53	86
21	54	87
22	55	88
23	56	89
24	57	90
25	58	91
26	59	92
27	60	93
28	61	94
29	62	95
30	63	96
31	64	97
32	65	98
33	66	99

Machine Hauling Equipment	Loading Equipment	Transportation
01	21	41
02	22	42
03	23	43
04	24	44
05	25	45
06	26	46
07	27	47
08	28	48
09	29	49
10	30	50

Skidding Equipment	Felling Equipment
11	31
12	32
13	33
14	34
15	35
16	36
17	37
18	38
19	39
20	40

Depreciation Method Codes for the Equipment Inventory Form

1 Straight Line
2 Sum-of-the-Years Digits
3 Declining Balance

Instructions for Preparing Daily Expense Form

1. Place your name, address, reporting period, and the code number for your business in the designated spaces on the Daily Expense Form.

2. Fill in the form daily.

3. Use the codes listed in this Appendix. A minimum entry will consist of the major expense code and the amount of the expenditure.

4. In column 1 place the two digit code representing the tract generating this entry.

5. In column 2 place the job code which describes your operation overall as a timber operation or in more detail as a pulpwood, sawtimber, or pole and piling operation.

6. In column 3 place the code describing the operation as either general cost of operation or break it down as a pine, hardwood, or mixed load operation and as either longwood or shortwood logging.

7. In column 4 place the code describing the phase of the operation incurring the cost.

8. In column 5 place the code describing the direct cost. These codes run from 1000 to 9000. If it is desirable to break these costs down to a specific employee or machine, codes are provided which may replace the two right-hand zero digits of the major code (pages 20 and 21).

9. Column 6 will be used for the listing of machine or labor hours.

10. In column 7 print an explanation of the transaction.

11. In column 8 place the amount of the expenditure.

12. Send in the forms weekly. Accurate and detailed information will provide better monthly and semi-annual reports.

Mississippi State University
Department of Forestry
Cost Accounting Project
Form Type 1
Producer ID _____
Reporting Period ___ To _____

Name _____

Address _____

_____

Daily Expense Form

Location	Job	Type	Phase	Major Expense	Hours Involved	Description	Amount

Instructions for Preparing the Equipment Inventory Form

1. Place your Producer ID in the designated space. Use the Employer's Identification Number assigned to you for payroll tax reports submitted to the federal government or your social security number as the Producer ID.

2. Date of Purchase: The date on which transfer of title was made.

3. Equipment ID: The Equipment ID can be any two digit code chosen from page 22 of this appendix.

4. Purchase Price: Your cost for the machine including freight costs and accessories minus any discount. If you buy used machinery, use the price you paid, not the original purchase price.

5. Depreciation Method: State the code number for the method of depreciation that you desire—1 is straight line, 2 is sum-of-the-years, and 3 is the declining balance method.

6. Expected Life: Use an estimate of how long the machine will be used by you based on past experience.

7. Expected Salvage Value: This is an estimate of the resale value of the machine at the end of its expected life.

8. Interest Rate: Use the loan interest rate.

9. Insurance: Report the annual sum of the premiums paid for fire, theft, damage, and liability insurance for this equipment (to the nearest dollar).

10. Taxes: Taxes consist of the annual sum of the sales tax and license fees for this piece of equipment.

11. Number of Payments: The total number of payments, due at time of purchase, which are necessary to repay any money borrowed for purchase of the machine.

12. Year of Manufacture: The year in which the equipment was manufactured.

13. Months Between Payments: The number of months between payments on debt.

14. Amount of Payment: The amount of each payment on the equipment loan (to the nearest dollar).

15. Amount Borrowed: The total amount of the equipment purchase loan.

16. Comments: Use this section to report any uncertainties you may have concerning data reported on the form.

Mississippi State University
Department of Forestry
Cost Accounting Project

Name _____
Address _____

Equipment Inventory Form

Form Number 3

Producer ID _____
Date of Purchase _____
Equipment ID _____
Purchase Price _____
Depreciation Method _____
Useful Life _____
Expected Salvage Value _____
Interest Rate _____
Insurance _____
Taxes _____
Number of Payments _____
Year of Manufacture _____
Months Between Payments _____
Amount of Payment _____
Amount Borrowed _____
Comments _____

Instructions for Preparing the Production Data Form

1. Place your name, address, reporting period, and the code number of the Producer ID for your business in the designated spaces on the Production Data Form.

2. Fill in the form daily.

3. In column 1 place the two digit code representing the tract of land generating this entry. If you do not desire to associate with a specific tract then leave this column blank.

4. In column 2 place the code for the produce category produced. (See page 24 of this Appendix).

5. In column 3 record the number of units removed.

6. In column 4 record the average round trip distance of the haul.

7. In column 5 record the number of hauls made daily.

8. In column 6 record the number of miles that equipment is used for business purposes other than hauling. For example, the number of miles on the crew truck.

9. In column 7 place a name or location you wish to use to designate the specific tract. (Optional).

10. Send in the forms weekly.

Mississippi State University
Department of Forestry
Cost Accounting Project
Form Type 2

Name _____

Address _____

_____

Producer ID _____
Reporting Period _____ To _____

Production Data Form

Location	Prod Type	Units Produced	Hauling Distance Round Trip	Number of Round Trips	Pick-up Miles	Name of Tract

Appendix 2

FORTRAN Source Program

```
      DIMENSION ISORT(100),IDEXP(2,99),IOUT(14),IFIX(3)
      DIMENSION JOB(2,4),ITYPE(2,7),PHASE(2,6)
      DIMENSION ID(12),FID(7),EXP(1000,3),UNITS(10,4,7,3),
     *TREST(100,3), SUM2(6,3), ID2(12), DEPR(100,3),
     *HDR1(4), HDR2(7), FUREP(100,2,3), DAT(2,10), PUMILE
     *(10,3), XMILES(10,3), MAJEXP(1000), T(3), EXPP(10,3),
     *J1(3)
      DIMENSION XT(3), TA(3), DE(3), TR(3), SUR(3), FU(3),
     *REP(3), BENMES(2,3), HOURS(3), AMT(3), TAXES(100,3),
     *HOUR2(6,3)
C
C
C     MOS IS MONTHS SINCE PURCHASE
C     MIP IS MONTHS INTO PERIOD
C     MODEP IS MONTHS OF DEPR LEFT
C     MOINP IS MONTHS INTO PERIOD
C     MODEP IS REMAINING MONTHS TO DEPRECIATE
C     PTRES IS INTREST RATE
C
C
      DATA  (IDEXP(I,10),I=1,2) / 'LABOR       '/
      DATA  (IDEXP(I,11),I=1,2) / 'RESERVED    '/
      DATA  (IDEXP(I,12),I=1,2) / 'RESERVED    '/
      DATA  (IDEXP(I,13),I=1,2) / 'REGULAR PAY '/
      DATA  (IDEXP(I,14),I=1,2) / 'OVERTIME    '/
      DATA  (IDEXP(I,15),I=1,2) / 'FICA        '/
      DATA  (IDEXP(I,16),I=1,2) / 'WORKMAN COMP'/
      DATA  (IDEXP(I,17),I=1,2) / 'UNEMP COMP  '/
      DATA  (IDEXP(I,18),I=1,2) / 'LABOR FRINGE'/
      DATA  (IDEXP(I,19),I=1,2) / 'INC TAX & SS'/
      DATA  (IDEXP(I,20),I=1,2) / 'REPAIRS     '/
      DATA  (IDEXP(I,21),I=1,2) / 'R REP PARTS '/
      DATA  (IDEXP(I,22),I=1,2) / 'R REP LABOR '/
      DATA  (IDEXP(I,23),I=1,2) / 'R REP TOTAL '/
      DATA  (IDEXP(I,24),I=1,2) / 'C REP PARTS '/
      DATA  (IDEXP(I,25),I=1,2) / 'C REP LABOR '/
      DATA  (IDEXP(I,26),I=1,2) / 'C REP TOTAL '/
      DATA  (IDEXP(I,30),I=1,2) / 'FUEL,FILTERS'/
      DATA  (IDEXP(I,31),I=1,2) / 'FUEL        '/
      DATA  (IDEXP(I,32),I=1,2) / 'LUBRICANTS  '/
      DATA  (IDEXP(I,33),I=1,2) / 'FILTERS     '/
      DATA  (IDEXP(I,40),I=1,2) / 'TAXES       '/
      DATA  (IDEXP(I,41),I=1,2) / 'SALES TAX   '/
      DATA  (IDEXP(I,50),I=1,2) / 'INSURANCE   '/
      DATA  (IDEXP(I,60),I=1,2) / 'HAND TOOLS  '/
      DATA  (IDEXP(I,70),I=1,2) / 'MIS BUS EXP '/
      DATA  (IDEXP(I,80),I=1,2) / 'INT-LOANS   '/
      DATA  (IDEXP(I,81),I=1,2) / 'INT-MACHINE '/
```

```
      DATA  (IDEXP(I,82),I=1,2) / 'SAFETY EQUIP'/
      DATA  (IDEXP(I,90),I=1,2) / 'LABOR HRS    '/
      DATA  (IDEXP(I,91),I=1,2) / 'MACHINE HRS '/
      DATA(IDEXP(I,99),I=1,2)/'  ','TOTAL'/
      DATA BENMES/'THIS MONTH','LAST MONTH','YEAR TO DATE/
      DATA DAT/'LABOR','  ','MAJOR REPAIR','FUEL,LUB,FIL'
     *'TAXES',' ','INSURANCE','HAND TOOLS','MISC BUS EXP'
     *'INTEREST','NON-EXP HRS','DEPRECIATION'/
      DATA HDR1/'       ','PULP','SAW','POLES'/
      DATA HDR2/'       ','P-SHRT','P-LONG','H-SHRT',
     *'H-LONG','MIX-S','MIX-L'/
      DATA JOB/'GENERAL','PULPWOOD','SAWTIMBER',
     *'POLE AND PIL'/
      DATA ITYPE/'GENERAL','PINE SHORT','PINE LONG',
     *'HARD SHORT','HARD LONG','MIXED SHORT','MIXED LONG'
      DATA PHASE/'GENERAL','FELLING BUCK','SKIDDING',
     *'LOADING','HAULING','TRANSPORT'/
      INTEGER TYP2 (10),EQUIP(100)
      REAL INSUR(100,3)
      ILAST=0
      IPRT=0


C
C     MONOW IS THE BEGINNING OF THE PRESENT PERIOD
C     MOLST IS THE BEGINNING OF THE LAST PERIOD
C     MOBEG IS THE BEGINNING DAY OF YEAR TO DAY
C     DATES ARE WRITTEN IN THE ORDER --- YR/MO/DAY
C
C

      READ(5,3) MONOW,MOLST,MOBEG
    3 FORMAT(3I6)
      READ(5,52) IOUT
      NWDS=14
      CALL SRTIN1 (IOUT,NWDS)
   53 READ(5,52,END=51) IOUT
      CALL FPOC(IOUT,NWDS)
      GO TO 53
   51 CALL ENDINP(IOUT,NWDS)
   52 FORMAT(13A6,A2)
      DECODE(1,IOUT)(ID(I),I=1,9),(FID(I),I=1,5),(ID(I),
     *I=10,12),FID(6),FID(7)
      GO TO 505
   50 CALL LPOC(IOUT,NWDS)
      DECODE(1,IOUT)(ID(I),I=1,9),(FID(I),I=1,5),(ID(I),
     *I=10,12),FID(6),FID(7)
C
C
C     THE ABOVE SORTS INPUT DATA ON 2-11,1,19-31
```

```
C
C
      IF (NWDS.EQ.9999)GO TO 100
    1 FORMAT(I1,I10,I7,I3,5I2,F8.0,2F5.0,F7.0,F5.0,2I2,
     *F6.0,F8.0)
  505 I1 = ID(3)/10000
      I2 = ID(3)/100-100*I1
      I3 = ID(3)- 100*I2-10000*I1
      MO=I1+100*I2+10000*I3
      J = 2
      IF(MO.GE.MONOW) J= 1
      IF(MO.LT.MOLST) J= 3
      IF(ILAST.EQ.0) GO TO 600
      IF(ID(2).NE.ID2(2)) GO TO 100
      IF(ID(1).EQ.1) GO TO 2
      ID(7) = ID(7) + 100*ID(6) +10000*ID(5)
      IF(ID(1).EQ.2) GO TO 6
      IF(ID(1).EQ.3) GO TO 7
      GO TO 1000
    2 MAJI=  ID(8)*100 +ID(9)
C
C
C
C     TYPE 1 FORM (DAILY EXPENSE SHEET)
C
C     ID(1) IS THE FORM TYPE
C     ID(2) IS THE PRODUCER ID
C     ID(3) IS THE REPORTING PERIOD
C     ID(4) IS THE LOCATION
C     ID(5) IS THE JOB
C     ID(6) IS THE TYPE
C     ID(7) IS THE PHASE
C     ID(8) IS THE MAJOR EXPENSE
C     ID(9) IS THE INDIVIDUAL OR MACHINE ASSOCIATED
C           WITH THE MAJOR EXPENSE
C     ID(I) I=10,12 IS BLANK
C     FID(1) IS THE HOURS INVOLVED
C     FID(I) I=2,6 IS BLANK
C     FID(7) IS THE AMOUNT OF THE MAJOR EXPENSE
C
C
C
      DO 5 K=4,8
      LBK = K-2
      IF(ID2(K).NE. ID(K)) GO TO 11
    5 CONTINUE
      HOURS(J) = HOURS(J)+ FID(1)
      AMT(J)=AMT(J)+FID(7)
```

```
      DO 9 I=1,MAJ
      IF(MAJEXP(I).EQ.MAJI) GO TO 8
    9 CONTINUE
      MAJ = MAJ+1
      I = MAJ
      MAJEXP(I) =MAJI
    8 EXP(I,J)=EXP(I,J)+FID(7)
      GO TO 50
C
C
C
C     TYPE 2 FORM (PRODUCTION FORM)
C
C     ID(1) IS THE FORM TYPE
C     ID(2) IS THE PRODUCER ID
C     ID(3) IS THE REPORTING PERIOD
C     ID(4) IS THE LOCATION
C     ID(I) I=5,8 IS BLANK
C     ID(9) IS THE PRODUCT TYPE
C     ID(I) I=10,12 IS BLANK
C     FID (1) IS UNITS PRODUCED
C     FID(2) IS HAUL MILES
C     FID(3) IS THE NUMBER OF ROUND TRIPS
C     FID(4) IS THE PICKUP MILES
C     FID(I) I=5,7 IS BLANK
C
C
C
    6 DO 21 I=1,MAJ2
      IF(ID(4).EQ.TYP2(I))GO TO 22
   21 CONTINUE
      MAJ2 = MAJ2+1
      I = MAJ2
      TYP2(I) = ID(4)
   22 K=ID(9)/10
      K1=ID(9)-10*K
      K=K+1
      K1=K1+1
      UNITS(I,K,K1,J)=UNITS(I,K,K1,J)+FID(1)
      XMILES(I,J) = XMILES(I,J) + FID(2) * FID(3)
      PUMILE (I,J) = PUMILE  (I,J) + FID(4)
      GO TO 50
C
C
C
C     TYPE 3 FORM (EQUIPMENT FORM)
C
C     ID(1) IS THE FORM TYPE
```

```
C       ID(2) IS THE PRODUCER ID
C       ID(3) IS THE DATE OF PURCHASE OF EQUIPMENT
C       ID(4) IS THE EQUIPMENT ID
C       ID(I) I=5,7 IS THE PURCHASE PRICE
C       ID(I) I=8,9 IS THE MONTHS BETWEEN PAYMENTS
C       ID(10) IS THE NUMBER OF PAYMENTS
C       ID(11) IS THE YEAR OF MANUFACTURE
C       ID(12) IS THE DEPRECIATION METHOD
C      FID(1) IS THE YEARS OF USEFUL LIFE
C      FID(2) IS THE EXPECTED SALVAGE VALUE
C      FID(3) IS THE INTEREST RATE
C      FID(4) IS THE INSURANCE COST
C      FID(5) IS THE TAXES
C      FID(6) IS THE AMOUNT OF PAYMENT
C      FID(7) IS THE AMOUNT BORROWED
C
C
C
     7 DO 23 I= 1, MAJ3
       IF(ID(4).EQ.EQUIP(I)) GO TO 24
    23 CONTINUE
       MAJ3 = MAJ3 + 1
       I = MAJ3
       EQUIP(I) = ID(4)
    24 MO1 = ID(3)/10000
       MO2 = ID(3)/ 100- MO1 *100
       MO 3 = ID(3)- MO1 *10000 -MO2*100
       YRS = MONOW/ 10000 - MO 3
       MOS=(MONOW/100 -(MONOW/10000)*100)
       MOS =  MOS -  MO2
       MOS=12*YRS+MOS+1
C
C
C      ABOVE  SHOULD BE  MONTHS  SINCE  PURCHASE
C
C
       J1(1)=1
       J1(2)= 1
       IF(MOLST.GE.MONOW)J1(2)=0.
C
C
C      MONTHS   INTO  PERIOD
C      TAXES, INSURANCE, DEPRECIATION
C
C
       MOINP =12*(MONOW/10000-MOBEG/10000)
       MOINP=MOINP+ (MONOW/100 - ((MONOW/10000) * 100)
      *(MOBEG/100 -((MOBEG/10000)*100))) + 1
```

```
      J1(3)= MOINP
      IF(MOINP.GT.MOS)J1(3)= MOS
      DO  751  J = 1,3
      TAXES(I,J)= TAXES(I,J) + FID(5)/ 12. *J1(J)
  751 INSUR(I,J)= INSUR(I,J) + FID(4)/ 12. *J1(J)
C
C
C     THE BELOW CALCULATES DEPRECIATION
C
C
      MODEP  = FID (1) * 12. -  MOS
      IF(MODEP.GE.0) GO  TO  752
      IF(MODEP.LT.-1) J1(1)=0.
      IF(MODEP.LT.-2) J1(2)=0.
      K = MOINP + MODEP
      IF(K.LE.0)  GO TO 31255
      J1(3)= K
  752 IF(FID(1).LE.0) GO TO 31255
      IF(ID(12).GT.1)  GO TO 9089
      DPR = (ID(7)- FID(2))/FID(1)/12.
      DO  754  J =  1,3
  754 DEPR(I,J) = DPR * J1(J) +DEPR(I,J)
C
C
C     THE BELOW IS DECLINING BALANCE AND SUM OF YEARS
C
C
      GO TO 31255
 9089 VAL=ID(7)
      MOBG=MOS-MOINP+1
      DEP=VAL/FID(1)*2./12.
      IF(ID(12).EQ.3) GO TO 9085
      J=FID(1)+.0001
      JM=J-1
      DO 9086 JK=1,JM
 9086 J=J+JK
      JK=J
      DEP=VAL*(JM+1)/JK/12.
 9085 DO 9082 J=1,MOS
      IF(J.GT.(FID(1)*12.0001)) GO TO 9084
      IF(((J-1)/12)*12.NE.(J-1)) GO TO 9083
C
C
C     SUM OF YEARS DEPRECIATION
C
C
      IF(J.EQ.1)  GO TO 9083
      IF(ID(12).EQ.3) GO TO 9087
```

```
      DEP=VAL*JM/JK/12.
      JM=JM-1
      GO TO 9083
C
C
C     DECLINING BALANCE DEPRECIATION
C
C
 9087 VAL=VAL-DEP*12.
      DEP=VAL/FID(1)*2./12.
 9083 IF(J.GE.MOBG)DEPR(I,3)=DEPR(I,3)+DEP
      IF(J.EQ.(MOS-1)) DEPR(I,2)=DEPR(I,2)+DEP*J1(2)
      IF(J.GE.MOS) DEPR(I,1)=DEPR(I,1) + DEP
 9082 CONTINUE
 9084 CONTINUE
31255 MOBG = MOS - MOINP + 1
C
C
C     INTEREST CALCULATION (MONTHLY INTEREST ON
C         REMAINING BALANCE)
C
C
  753 PRIN =  FID(7)
      IF(MOS.LE.0) GO TO 800
      DO  757  J =  1, MOS
      IF (ID(9).EQ.0) GO TO 800
      PTRES =FID(3)/12.* PRIN/100.
      PRIN = PRIN - (FID(6)/(ID(9) +100* ID(8)) -PTRE
      IF ( J.GE.MOBG ) TREST(I,3) = TREST(I,3) +  PTR
      IF(J.EQ.(MOS-1)) TREST(I,2)=TREST(I,2)+PTRES*J1
      IF (J.GE. MOS )  TREST (I, 1)= TREST(I,1) +PTRE
      IF(PRIN.LE.0) GO TO 800
  757 CONTINUE
  800 CONTINUE
      GO TO 50
C
C
C             BREAK IN PRODUCER
C
C
  100 LBK= 1
   11 CONTINUE
C
C
C             BREAK IN  CATEGORY
C
C
  655 IBK=LBK
```

```
      HOURS(3)= HOURS(3) + HOURS(2) + HOURS(1)
      AMT(3) = AMT(3) +  AMT(2)+ AMT(1)
      DO 30 J= 1, 3
      DO 31 I = 1,6
      HOUR2(I,J)=HOUR2(I,J) + HOURS(J)
   31 SUM2(I,J) = SUM2(I,J) + AMT(J)
      AMT(J)=0.
   30 HOURS(J)=0.
      ITOT = 7-IBK
      ISAVE=ID2(2)
   57 FORMAT(' ',2A6)
      IPT=1
      DO 32 I=1,ITOT
      J4=ID2(8)
      IF(J4.GT.99)J4=99
      IF(IPT.EQ.0) GO TO 3098
      WRITE(6,609) (IDEXP(I1,J4),I1=1,2),(SUM2(I,J),J=1,3
     *(HOUR2(I,J),J=1,3)
  609 FORMAT(' ',6X,2A6,6F10.2)
      ID2(8)=99999999
      IPT=0
 3098 DO 3097 J=1,3
      IF(SUM2(I,J).NE.SUM2(I+1,J)) IPT=1
 3097 CONTINUE
      DO 32 J=1,3
      HOUR2(I,J)=0.
   32 SUM2(I,J)=0.
  600 IF(LBK.EQ.1) GO TO 6003
      IF (ID2(4).NE.ID(4).OR.ID2(5).NE.ID(5).OR.ID2(6).
     *NE.ID(6))GO TO 54
      GO TO 6007
   54 I=ID(5)+1
      J=ID(6)+1
      WRITE(6,606)ID(2),ID(4),JOB(1,I),JOB(2,I),ITYPE(1,J,
     *ITYPE(2,J)
  606 FORMAT('1','EXPENDITURES FOR PRODUCER',I12,
     *'   LOC',I3,4(1X,2A6))
      WRITE(6,607)
  607 FORMAT('0',2X'PHASE',21X,'EXPENSES',14X,'HOURS',/
     *' ',18X,'THIS    LAST    YR TO THIS LAST YR TO'/
     *' ',17X,'MONTH   MONTH     DATE  MTH  MTH  DATE')
      I=ID(7) +1
      GO TO 6009
 6007 I=ID(7)+1
      IF(ID2(7).EQ.ID(7))GO TO 6003
 6009 WRITE(6,57) PHASE(1,I),PHASE(2,I)
 6003 DO 401 I=1,12
  401 ID2(I)=ID(I)
```

```
      DO 905 J=1,3
      T(J)=0.
      DO 905 I=1,10
  905 EXPP(I,J) =0.
      ILAST=1
      IF( IBK.NE.1) GO TO 505
C
C
C     END OF PRODUCER
C
C
      WRITE(6,608) ISAVE
  608 FORMAT('1','MAJOR EXPENDITURES FOR PRODUCER',I12)
      WRITE(6,611)
  611 FORMAT('0',1X,'MAJ. EXP.',2X,'THIS MONTH',2X,
     *'LAST MONTH',2X,'YEAR TO DATE',/' ')
      DO  41 I=1, MAJ
      EXP(I,3) = EXP(I,3)+EXP(I,1)+EXP(I,2)
      WRITE ( 6,601) MAJEXP(I),(EXP(I,J),J=1,3)
  601 FORMAT(' ', I10,3F12.2)
      K=MAJEXP(I)/1000
      IF(K.EQ.2.OR.K.EQ.3) GO TO 2005
      GO TO 2006
 2005 KM=MAJEXP(I)-(MAJEXP(I)/100)*100
      DO 2007 J=1,MAJ3
      IF(KM.EQ.EQUIP(J)) GO TO 2008
 2007 CONTINUE
      MAJ3=MAJ3+1
      J=MAJ3
      EQUIP(J)=KM
 2008 DO 2009 L=1,3
 2009 FUREP(J,K-1,L)=FUREP(J,K-1,L)+EXP(I,L)
 2006 CONTINUE
      MAJEXP(I) = 0
      DO 41 J=1,3
      EXPP(K,J)=EXPP(K,J) + EXP(I,J)
      T(J)=T(J)+EXP(I,J)
   41 EXP(I,J)=0.
      WRITE(6,901)(T(J),J=1,3)
  901 FORMAT('0',5X,'TOTAL',3F12.2)
      MAJ =0
      WRITE (6,613)  ISAVE
  613 FORMAT('1','PRODUCTION FOR PRODUCER',I12)
      WRITE(6,617)
  617 FORMAT('0',16X,2X,'THIS MONTH',2X,'LAST MONTH',2X,
     *'YEAR TO DATE')
      DO 46 I=1,MAJ2
      WRITE(6,614) TYP2(I)
```

```
614 FORMAT('0','LOCATION',I3,/' ')
    DO 45 K=1,4
    DO 45 K1=1,7
    UNITS(I,K,K1,3)=UNITS(I,K,K1,3)+UNITS(I,K,K1,1)
   *+UNITS(I,K,K1,2)
    IF(UNITS(I,K,K1,3).LE.0.) GO TO 45
    WRITE(6,603) HDR1(K),HDR2(K1),(UNITS(I,K,K1,J),J=1,)
 45 CONTINUE
    WRITE(6,623)
623 FORMAT(' ','MILES TRAVELED')
    XMILES(I,3)=XMILES(I,3)+XMILES(I,1)+XMILES(I,2)
    PUMILE(I,3)=PUMILE(I,3)+PUMILE(I,2)+PUMILE(I,1)
    WRITE(6,604)(XMILES(I,J),J=1,3)
    WRITE(6,605) (PUMILE(I,J),J=1,3)
603 FORMAT(' ',4X,2A6,3F12.2)
604 FORMAT(' ',4X,'HAUL-MILES',3F12.2)
605 FORMAT(' ',4X,'PICK-UP',3X,3F12.2)
    DO 46 J=1,3
    XMILES(I,J)=0.
    PUMILE(I,J)=0.
 46 CONTINUE
    DO 2198 J=1,3
    XT(J)=0.
    TA(J)=0.
    DE(J)=0.
    TR(J)=0.
    SUR(J)=0.
    FU(J)=0.
    REP(J)=0.
2198 CONTINUE
    DO 915 I=1,MAJ3
915 ISORT(I)=EQUIP(I)
    DO 916 J=1,MAJ3
    DO 916 I=2,MAJ3
    IF(ISORT(I-1).LE.ISORT(I))GO TO 916
    I1=ISORT(I)
    ISORT(I)=ISORT(I-1)
    ISORT(I-1)=I1
916 CONTINUE
    DO 642 J=1,3
    WRITE(6,624) (BENMES(I,J),I=1,2)
624 FORMAT('1','EQUIPMENT EXPENSES',/' ',2A6)
    WRITE(6,625)
625  FORMAT('0','EQUIP.',4X,'TAXES',2X,'DEPREC.',1X,
   *'INTEREST',1X,'INSURANCE',1X,'MAJ. REP.',3X,'FUEL',
   *4X,'TOTAL',/' ')
    DO 42 I1=1,MAJ3
    DO 917 I=1,MAJ3
```

```
      IF(ISORT(I1).EQ.EQUIP(I))GO TO 918
  917 CONTINUE
  918 CONTINUE
      X=TAXES(I,J)+DEPR(I,J)+TREST(I,J)+INSUR(I,J)
     *+FUREP(I,1,J)+FUREP(I,2,J)
      XT(J)=XT(J)+X
      WRITE(6,602)EQUIP(I),TAXES(I,J),DEPR(I,J),TREST(I,J)
     *INSUR(I,J),FUREP(I,1,J),FUREP(I,2,J),X
  602 FORMAT(' ',I6,7F9.2)
      TA(J)=TA(J)+TAXES(I,J)
      DE(J)=DE(J)+DEPR(I,J)
      TR(J)=TR(J)+TREST(I,J)
      SUR(J)=SUR(J)+INSUR(I,J)
      FU(J)=FU(J)+FUREP(I,2,J)
      REP(J)=REP(J)+FUREP(I,1,J)
      DO 3012 L=1,2
 3012 FUREP(I,L,J)=0.
      TAXES(I,J)=0.
      DEPR(I,J)=0.
      TREST(I,J)=0.
   42 INSUR(I,J)=0.
  642 WRITE(6,903)TA(J),DE(J),TR(J),SUR(J),REP(J),FU(J),
     *XT(J)
  903 FORMAT('0',1X,'TOTAL',7F9.2)
      MAJ3 = 0
      IPRT=0
      WRITE(6,2019)
 2019 FORMAT('1','TOTAL EXPENSES',2X,'THIS MONTH',2X,
     *'LAST MONTH',2X,'YR TO DATE'/' ')
      DO 2197 J=1,3
      EXPP(4,J)=TA(J)
      EXPP(5,J)=SUR(J)
      EXPP(8,J)=TR(J)
 2197 EXPP(10,J)=DE(J)
      DO 2003 I=1,10
      IF(EXPP(I,3).LE.0.) GO TO 2003
      WRITE(6,2004) (DAT(J,I),J=1,2),(EXPP(I,J),J=1,3)
 2004 FORMAT(' ',2A6,3F12.2)
 2003 CONTINUE
      DO 2017 J=1,3
      T(J)=0.
      DO 2017 I=1,10
 2017 T(J)=T(J)+EXPP(I,J)
      WRITE(6,2018) T(1),T(2),T(3)
 2018 FORMAT('0',7X,'TOTAL',3F12.2)
      WRITE(6,2021)
 2021 FORMAT('0','TOTAL PRODUCTION',/' ')
      DO 2046 I=2,MAJ2
```

```
      DO 2046 K=1,4
      DO 2046 J=1,3
      DO 2046 K1=1,7
      UNITS(1,K,K1,J)=UNITS(1,K,K1,J)+UNITS(I,K,K1,J)
2046  UNITS(I,K,K1,J)=0
      DO 2045 K=1,4
      DO 2045 K1=1,7
      IF(UNITS(1,K,K1,3).LE.0.)GO TO 2047
      WRITE(6,1603)HDR1(K),HDR2(K1),(UNITS(1,K,K1,J),J=1,3)
1603  FORMAT(' ',2A6,3F12.2)
2047  DO 2048 J=1,3
2048  UNITS(1,K,K1,J)=0.
2045  CONTINUE
      MAJ2=0
      IF (NWDS.NE.9999) GO TO 505
1000  WRITE(6,1604)
1604  FORMAT('1',1X,'COMPLETE')
      STOP OK
      END
@ASM,SI    TEMP,SUB
;PRM1* R$FILE 'VRSZ',80,32 ;
       'KEY',2,10,'A','A',1 ;
       'KEY',1,1,'A','A',2 ;
       'KEY',19,13,'A','A',3 ;
       'FPOC',FPOC ;
      'LPOC',LPOC ;
       'COPY',RSTD$.
      END
```

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TECHNICAL AND ECONOMIC EFFICIENCY OF HARVESTING AND HANDLING SEED COTTON IN THE MISSISSIPPI DELTA DURING THE FIRST HARVEST, 1971

MAFES

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Technical and Economic Efficiency of Harvesting and Handling Seed Cotton in the Mississippi Delta During the First Harvest, 1971

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Variation among individual farms in the ources employed and time required and costs incurred in accomplishing a given is characteristic. Wide differences in efency are often observed when apparently ilar land, equipment, labor, and capital ources are available for managerial use. Classification of farms into efficiency ups should enable the manager of a given m operation to compare his operational racteristics with other more or less effint producers. Evaluation of these differces may indicate where and how much imvement the farm operator might expect m more efficient utilization of his avail- e resources.

The specific purpose of this publication is examine variations in the technical and nomic efficiencies associated with harsting and handling seed cotton in the Missippi Delta during the first harvest of the 71 season.

Procedure

An earlier publication contains detailed cedures utilized in collection of these ta (1). Several of the original study farms re eliminated due to missing or incomte sets of observations.

Farms were separated into three efficiengroups on the basis of farm cooperator reported data (hours required for stalk to trailer transfer of one acre or one bale of seed cotton) and on the basis of costs incurred during the process of harvesting, handling, and ginning one bale of seed cotton. The analysis of each efficiency criteria utilized a common statistical measure to determine which particular efficiency group a farm belonged.[2/]

Tabular values are unweighted farm means for a particular variable. cost data assume that all fixed costs and repair costs are charged against first harvest operations. Therefore, any harvester or trailer use during the second harvest would only incur direct fuel and labor operating expenditures for that particular period (2). The same type of costs would be incurred during custom operations on other farms.

Results

Technical efficiency

Hours per acre. Hours per acre is a common measure of machine efficiency (2, 5). In this study it was the time required for stalk to trailer transfer of seed cotton during the first harvest season of 1971 as reported by cooperating farmers. The more efficient group of farmers was able to transfer one acre of seed cotton from stalk to trailer in 0.64 hour (Table 1). Farmers in the average

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[2/] Units of standard deviation were utilized as follows to establish each efficiency grouping:

More efficient - included those farms with mean values more than one-half unit of standard deviation less than the observed mean for all farms.

Average efficient - included those farms with mean values plus or minus one-half unit of standard deviation from the observed means for all farms.

Less efficient - included those farms with mean values more than one-half unit of standard deviation greater than the observed mean for all farms.

group required 0.83 hour for each acre harvested. These data reported by farmers are similar to those reported from an earlier study of machinery performance rates (2, p. 4). The less efficient group required 64% more time (1.05 hours per acre) for the first harvest than did the more efficient farmers. Since the total number of hours suitable for picking during a given season is limited in the Mississippi Delta (2), these variations in performance rates should be a significant factor in producer planning of cotton acreage to be harvested by a given equipment resource base.

Table 1. Resource requirements and cost for harvesting, handling, and ginning seed cotton on 23 Mississippi Delta farms divided into efficiency groups on the basis of hours required to harvest one acre of cotton during the first harvest, 1971.

Item	Efficiency group		
	More	Average	Less
Number of farms	6	10	7
Farmer reported data[1]/			
Hours per acre	0.64	0.83	1.5
Hours per bale	0.50	0.67	0.4
Acres of cotton	453	517	3
Yield, bales per acre	1.36	1.36	1.4
Breakdown time, %	5.0	5.9	3
Acres of cotton per bale of trailer capacity	7.2	12.1	1
Number of harvesters	1.7	2.2	
Number of harvester heads	3.4	3.8	4
Age of harvesters, years	3.5	6.2	9
Cost of harvesters, $2/	22,409	19,391	15,5
Enumerator recorded data[3]/			
Size of trailers utilized, bales	5.5	5.2	4
Turnrow trailer capacity, end of observation period, bales	9.0	7.6	4
Dump size, bales	1.57	1.23	0.
Dump time, minutes per bale	2.26	2.12	2.
Labor utilized per harvester unit			
Driver	1.00	1.00	1.0
Packers and clean out personnel	0.75	0.70	0.9
Haulers	0.11	0.20	0.
Managers	0.08	0.14	0.0
Total costs for harvesting, handling and ginning seed cotton, $2/			
Per acre	51.57	46.82	45.0
Per bale	39.19	35.45	30.5

[1]/ Cooperating farmers reported bales picked, hours picked, and breakdown time on a daily basis during the 1971 harvest season.

[2]/ Detailed assumptions for cost calculations are included in footnotes, Table 3.

[3]/ Enumerators collected detailed time and motion data on each farm at least once during the 1971 first harvest season. The average observation period on these farms began at 9:58 a.m. and ended at 4:56 p.m.

Yield per acre is likely to influence the rate which machinery is able to cover a given e or area. In this study no difference in ld per acre was reported by the average or re efficient groups. The less efficient up reported yields of 0.15 bale more seed ton per bale more seed cotton per acre an either of the more efficient groups. erefore, the advantage in efficiency for the re efficient farmers declined to 48% en seed cotton yield variations were nsidered.

Field breakdown times in excess of 30 nutes as reported by farm cooperators re slightly less for the less efficient group. ower field performance rates may contri- te to these less frequent breakdowns. It is o possible that preventative maintenance easures were more intensively employed r the older harvesters in the less efficient oup.

The more efficient group of farmers had a ger total supply of trailer capacity per acre cotton than either of the other groups. eld enumerators observed that the effi- ent producers utilized larger trailers and pt a larger quantity of trailer capacity ailable in the field than did either the erage or less efficient groups of farmers.

Age and initial cost of harvester units were osely related to the time required to harvest e acre. The more efficient producers were ing harvesters averaging 3.5 years of age ith an average initial cost of $22,243 per it. In contrast, less efficient producers ere operating harvesters averaging 9.2 ears old with an initial cost of $15,505 each. he acres harvested by a harvesting unit eclined as efficiency declined.

Detailed observations of managerial tech- iques by field enumerators indicated that as he efficiency of operation increased the pro- portion of the available harvesting period evoted to a lunch period declined (7.1, 5.2, nd 1.8% for less, average, and more effi- ient groups, respectively).

Overall dump time per bale was about the ame with group means ranging from 2.1 to .4 minutes per bale dumped.

The more efficient managers utilized a smaller turn-row labor force per harvester unit, even though the size of sump was considerably larger for the harvesters used by this efficiency group.

Total costs for harvesting, handling and ginning seed cotton both on a per acre and per bale basis, were greatest for the farms with the more efficient performance rates per acre. The predominant reason for cost differentials was the difference among groups in the age of the harvesters utilized. Such a high cost component used only during the cotton harvesting season has significant upward pressure on costs, especially in the early years of depreciation.

Hours per bale.[3]/ It is difficult to fully evaluate any segment of the cotton production process without giving some attention to yield of seed cotton. The time measure here includes the period required to remove the cotton from the stalk and place it into a trailer for transport to a gin.

The more efficient producers were able to harvest one bale of cotton in 0.45 hour (Table 2). In contrast, the less efficient group required 0.92 hours to harvest each bale. Seed cotton yields were 1.69, 1.30, and 1.06 bales per acre for more, average, and less efficient groups, respectively. It is evident that this measure of harvesting efficiency was closely related to cotton yields.

The farmers in the higher efficiency group were placing heavy pressure on their trailer capacities. They had more acres of higher yielding cotton per bale of trailer capacity than either of the other groups. These farmers were using considerably larger trailers than were the farmers in the other two groups.

The age of harvesters increased while initial costs per harvester unit declined as the hours required to harvest one bale of cotton increased. Acres picked per harvester were less as efficiency level dropped. Bales picked by each harvesting unit decreased quite rapidly as efficiency level declined.

The less efficient group of producers utilized considerably less packer, cleanout, and hauling labor per harvesting unit than either of the other groups. The more effi-

[3] While composed of the same 23 farms, the groupings here were entirely independent of those included in either the preceding or following sections.

cient managers devoted a significantly larger proportion of direct managerial input to the cotton harvesting and handling process (0.20 man units per harvester vs. 0.00 and 0.02 man units for average and less efficient farms, respectively). This may suggest that managers in the more efficient group de te more personal attention to the entire co on production process as evidenced by th higher yields of cotton per acre and mor f- ficient transfer of seed cotton from stal o trailer.

Table 2. Resource requirements and cost for harvesting, handling, and ginning seed cotton on 23 Mississippi Delta farms divided into efficiency groups on the basis of hours required to harvest one bale of cotton during the first harvest, 1971.

Item	Efficiency group		
	More	*Average*	*L*
Number of farms	9	8	6
Farmers reported data[1]/			
Hours per bale	0.45	0.67	(
Hours per acre	0.76	0.86	(
Acres of cotton	598	390	
Yield, bales per acre	1.69	1.30	
Breakdown time, %	5.4	5.9	
Acres of cotton per bale of trailer capacity	11.9	9.0	1
Number of harvesters	2.2	1.8	
Number of harvester heads	4.4	3.6	
Age of harvesters, years	4.3	6.6	
Cost of harvesters, $2/	21,397	18,853	15,
Enumerator recorded data[3]/			
Size of trailers utilized, bales	5.8	4.9	
Turnrow trailer capacity, end of observation period, bales	7.0	8.1	
Dump size, bales	1.45	1.14	
Dump time, minutes per bale	2.52	2.05	
Labor utilized per harvester unit			
Drivers	1.00	1.00	
Packers and clean out personnel	0.87	0.89	
Haulers	0.21	0.18	
Managers	0.19	0.00	
Total cost for harvesting, handling and ginning seed cotton, $2/			
Per bale	32.52	37.74	34
Per acre	54.66	46.44	37

[1]/ Cooperating farmers reported bales picked, hours picked, and breakdown time on a daily basis during the 1971 harvest season.

[2]/ Detailed assumptions for cost calculations are included in footnotes, Table 3.

[3]/ Enumerators collected detailed time and motion data on each farm at least once during the 1971 first harvest season. The average observation period on these farms began at 9:58 a.m. and ended at 4:56 p.m.

otal costs per bale for harvesting, ling, and ginning by the more efficient ducers totaled $32.52, less than either of other groups. These lower costs per bale e probably associated with the relatively per acre yields. Total costs per acre were itest for the more efficient group and t for the less efficient producers.

nomic efficiency

conomic efficiency is slightly different m technical efficiency. The following de- tion of the term "economic efficiency" is propriate: "The less the dollar value of ource input needed per dollar's worth of duct output, the greater is economic effi- ncy" (3). The "product" in this study is a e of ginned cotton. The "resource inputs" those labor and capital items required to oduce one bale of lint cotton from stalk ough ginned product during the first rvest of 1971.

When arrayed into efficiency groups on basis of total stalk through ginning costs, vide variation in both costs per bale and sts per acre was observed (Table 3).[4]/ The st efficient farmers were able to harvest, ndle, and gin one bale of cotton for $28.21 5.9¢ per pound of lint cotton. The less ef- ient group expended $53.90 per bale or .2¢ per pound of lint to accomplish the me tasks. Aside from ginning costs, the rgest single cost item for cotton harvesting as for owning and operating a spindle cker. Harvester costs were $6.46, 3.03, and $30.47 per bale, respectively for ore, average, and less efficient producers.

The more efficient producers spent less oney per bale on harvesters and trailers nd more for each bale harvested on labor nd hauling costs. These producers utilized lder harvesters (8.6 years average age) hich required about the same or slightly ore hours to harvest a bale of cotton and .18 to 0.12 hour longer to harvest one acre. herefore, the more efficient producers ould expect to harvest fewer acres with one arvester unit than either of the other roups.

The more efficient producers were plac- ng heavy pressure on trailer capacity with 12.0 acres of cotton per unit of capacity and 1.53 bales per acre first harvest yield.

A slightly greater intensity of turnrow assistance per harvester unit was maintained by the more efficient producers.

The less efficient group contained only 3 farms with relatively small acreages and low yields of cotton per acre. Farmers in this group would have to expand their own production or become involved in custom harvesting to justify their level of capital investment in both cotton harvesters and trailers.

Farmer reported field breakdown times in excess of 30 minutes were quite similar for all groups on a proportional basis. This suggests that the high investment capital equipment required for cotton harvesting can be maintained in useful service over relatively long periods of time and as a result reduce total harvesting costs, both on a per acre and per bale basis.

Summary

A detailed study was made of the resources utilized by 23 Mississippi Delta farms in accomplishing the first harvest of 1971. This study included consideration of the variation in efficiency of operation based on three measures: (1l) hours required to harvest one acre; (2) hours required to harvest one bale; and (3) total cost of harvesting, hauling, and ginning one bale of cotton.

Stalk to trailer transfer of one bale of seed cotton required 0.45, 0.67, and 0.92 hour, respectively, for the more efficient, average, and less efficient producers when efficiency was defined as the time required to harvest one bale of seed cotton. Total harvesting, hauling, and ginning costs ranged from $32.52 to $37.74 per bale.

Efficiency groups based on total harvesting, hauling, and ginning costs indicated that the more efficient producers were using older harvesters (9.2 years average age), more acres of cotton per unit of trailer capacity (12.0), and more turn-row labor per harvesting unit than either the average or less efficient groups. Total costs ranged from $28.21 to $53.90 per bale of cotton. The less efficient group was characterized by rela-

/ While composed of the same 23 farms, the groupings here were entirely independent of hose included in either of the preceding sections.

Table 3. Costs and resource requirements for harvesting and handling seed cotton on 23 Mississippi Delta farms divided into efficiency groups on the basis of total costs incurred for harvesting, handling, and ginning seed cotton during the first harvest, 1971.

Item	Efficiency group	
	More	Average
Number of farms	8	12
Total cost for harvesting, handling and ginning seed cotton, $		
Per bale	28.21	34.66
Per acre	42.83	47.14
Component costs for harvesting, handling and ginning seed cotton, $/bale		
Harvester[1]/	6.46	13.03
Trailer[2]/	1.50	2.01
Labor[3]/	2.52	2.01
Hauling[4]/	0.45	0.33
Tractor[5]/	0.15	0.15
Ginning[6]/	17.13	17.13
Farmer reported data[7]/		
Hours per bale	0.68	0.60
Hours per acre	0.96	0.78
Acres of cotton	503	483
Yield, bales per acre	1.53	1.37
Breakdown time, %	4.5	5.0
Acres of cotton per bale of trailer capacity	1.20	10.5
Age of trailers, years	9.7	8.7
Number of harvesters	2.1	1.9
Number of harvester heads	4.2	3.7
Age of harvesters, years	8.6	5.0
Cost of harvesters, $[1]/	16,507	20,686
Enumerator recorded data[8]/		
Size of trailers utilized, bales	4.9	5.5
Dump size, bales	0.93	1.44
Dump time, minutes per bale	2.27	2.35
Labor utilized per harvester unit		
Drivers	1.00	1.00
Packers and clean out personnel	0.85	0.78
Haulers	0.22	0.16
Managers	0.12	0.08

[1]/ **Harvester costs were based on average costs for a given model machine as reported by a random sample of Mississippi Delta farmers in 1971. The depreciation period was assumed to be 10 years with a zero salvage value. Interest costs on current investment level were calculated at an annual rate of 8%. Farmer reported ages and performance rates were utilized in determining individual harvesting costs on individual farms. Repairs and operating costs were based on previously published estimates (2).**

able 3 (Continued)

railer costs were determined in a similar fashion to harvesters, except that the depreciation period was assumed to be 12 years.

abor costs were calculated for individual farms at the following wage rates: Drivers and ackers and clean out personnel, $1.50 per hour; haulers, $2.50 per hour; and managers, 3.00 per hour.

Hauling costs were estimated based on average trailer capacity used and distance to the gin or each respective farm.

Tractor costs for spotting trailers for harvesters were essumed to be $0.15 per bale.

Ginning costs per bale were assumed to be the same for all farms and were obtained from a ecent publication (4)

Cooperating farmers reported bales picked, hours picked, and breakdown time on a daily asis during the 1971 harvest season.

Enumerators collected detailed time and motion data on each farm at least once during the 971 first harvest season. The average observation period on these farms began at 9:58 a.m. nd ended at 4:56 p.m.

ely high levels of both picker and trailer vestment and low yields of cotton per acre. Except for ginning cost which was not reted to other costs in this study, harvester osts were the largest component of total osts (22.9, 37.6, and 56.5% for the more, erage, and less efficient groups, respecvely).

These results indicate that capital investent items used in cotton harvesting (i. e., ickers and trailers) can be maintained for atiffactory operation over many production periods. Producers who properly mained such items over an extended life were ble to harvest, haul, and gin their cotton rop for less total expenditures than were operators utilizing newer, more expensive items.

Performance rates (both hours per acre and hours per bale) and total annual bale and acre capacities were in favor of producers utilizing newer harvesters. The very high fixed costs of newer harvesting units overshadowed their superior field performance rates and prevented a reduction in per bale harvesting costs.

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